The Engineer

LONDON, FRIDAY, AUGUST 8, 1941.

PUBLIC NOTICES

COUNTY BOROUGH OF SOUTHPORT

GAS DEPARTMENT

The Gas Committee Invite TENDERS for the SUPPLY, DELIVERY, and ERECTION at the Gasworks, Blowick, Southport, of a CAST IRON or STEEL TANK, capable of storing 100,000 gallons of Tar and Ammoniacal Liquor.

Full particulars of requirements may be obtained on application to Jno. L. Anderson, Acting Engineer and Manager, 91, Eastbank Street, Southport.

Tenders, stating period required for delivery, to be addressed to the undersigned, in plain sealed envelope, endorsed "Storage Tank," so as to arrive not later than the first post on Monday, the 18th August, 1941.

The Council do not bind themselves to accept the lowest or any Tender.

R. EDGAR PERRINS, LL.M.,
Town Clerk.

Town Hall,
Southport,
30th July, 1941. 7659

THE TEES VALLEY WATER BOARD

THE PROVISION AND INSTALLATION OF AMMONIATION AND CHLORINATION APPARATUS

Contractors with Experience in the Provision and Installation of Ammoniation and Chlorination Apparatus, who are desirous of TENDERING for the above-mentioned WORK, in accordance with the drawings, general and special conditions of contract, specification, schedule, and other particulars prepared by the undersigned, are INVITED to MAKE APPLICATION for the DOCUMENTS, which will be ready for issue on Wednesday, 13th August, 1941.

Only contractors experienced in the class of work described in the specification and who have undertaken similar work for a period of at least three years may tender, and it is requested that particulars of three such installations shall be furnished with the Tender.

The contractor whose Tender is accepted will be required to enter into a contract under seal prepared by the Board, and to provide a surety by an approved Guarantee Society.

A deposit of Three Guineas, which should be enclosed with the application for the documents, will be required. This sum is returnable upon the receipt of a bona fide Tender, provided the Tender is not subsequently withdrawn.

Tenders, sealed within the envelopes provided by the Board, and not endorsed with any mark or name identifying the senders, will be considered only if received by the undersigned not later than 10 a.m. on the 27th August, 1941.

T. S. R. WINTER,
Assoc. M. Inst. C.E.,
Acting General Manager and Engineer.

Water Board Offices,
Corporation Road,
Middlesbrough. 7667

MANCHESTER SHIP CANAL COMPANY

APPOINTMENT OF ASSISTANT TO CHIEF ENGINEER

Applications are Invited for the POSITION of ASSISTANT to the CHIEF ENGINEER, at a commencing salary of £1000 per annum.

Candidates should not exceed 45 years of age, must be Corporate Members of the Institution of Civil Engineers, and be experienced in the Design, Construction, and Maintenance of Dock and Harbour Works.

Applications, stating age, qualifications, and previous experience, should be addressed to the GENERAL MANAGER, MANCHESTER SHIP CANAL COMPANY, SHIP CANAL HOUSE, MANCHESTER, 2, not later than August 25th, 1941. Envelopes to be marked "Personal."

Testimonials need not accompany applications. 7652

MIDDLESEX COUNTY COUNCIL

SHIFT CHARGE ENGINEER

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Written application to the undersigned by 15th August, 1941, stating nationality, age, and experience.

C. W. RADCLIFFE, "D2,"
Clerk of the County Council.

Guildhall,
Westminster, S.W.1. 7662

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The SESSION COMMENCES on THURSDAY, SEPTEMBER 25th.

DEPARTMENTS.

Professor A. H. GIBSON, D.Sc., LL.D., M. Inst. C.E. M.I. Mech. E. (Engineering).
Professor WILLIS JACKSON, D.Sc., D. Phil., A.M.I.E.E., F. Inst. P. (Electrical Engineering).
Professor L. J. MORDELL, B.A., M.Sc., F.R.S. (Pure Mathematics).
Professor A. R. TODD, D.Sc., Dr. phil. nat., D. Phil. (Organic Chemistry).
Professor MICHAEL POLANYI, M.Sc., M.D., Ph.D. (Physical Chemistry).
Professor P. M. S. BLACKETT, M.A., F.R.S. (Physics).
Professor D. R. HARTREE, M.A., M.Sc., Ph.D., F.R.S. (Theoretical Physics).
Professor F. C. THOMPSON, M.Sc., D.Met. (Metallurgy).
Professor W. J. PUGH, O.B.E., D.Sc., B.A. (Geology). 7663

The Engineer

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All correspondence dealing with Editorial, Advertising and Subscription Matters should be addressed to: 28, ESSEX STREET, STRAND, LONDON, W.C. 2

Remittances and Letters dealing with Accounts should be sent to:

"THE ENGINEER," Accounts Dept.,
***c/o* The Pitman Press,**
Lower Bristol Road,
Bath, Somerset.

PUBLIC NOTICES

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THE SECRETARY, University College, Dundee.

SESSION COMMENCES OCTOBER, 1941. 7660

PUBLIC NOTICES

GLAMORGAN EDUCATION COMMITTEE

SCHOOL OF MINES AND TECHNOLOGY, TREFOREST

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F. E. REES,
Director of Education.

County Hall, Cardiff. 7649

PUBLIC NOTICES

UNIVERSITY OF MANCHESTER

PHYSICS DEPARTMENT

Full Particulars of the LECTURES and LABORATORY COURSES in PHYSICS, preparing for both the Ordinary and Honours Degrees, will be forwarded on application to the REGISTRAR.

The SESSION COMMENCES on THURSDAY, SEPTEMBER 25th. 7664

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The Engineer

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Letters relating to the Advertisement and the Publishing Departments of the Paper are to be addressed to the Publisher, all other letters are to be addressed to the Editor of THE ENGINEER.

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A Seven-Day Journal

London Area Clearing Centres

In a letter to *The Times* on the subject of increasing production, Mr. Rupert Brabner states that much can be done to increase productive effort in the existing framework set up by the Ministry of Supply and the Ministry of Labour and National Service. The London and South-Eastern Area Board has set up no less than ten clearing centres in order to deal with the 15,000 firms engaged on engineering and non-engineering work which possess machinery in the London area. Each of these centres, Mr. Brabner goes on to say, is in charge of technical and labour supply officers, and each has a district Advisory Committee, composed of workpeople and employers, to mobilise the goodwill of local industry and to make use of a knowledge of local conditions. These centres act as machine tool capacity exchanges, and with the information given by the machine tool census the technical officers can use to the full spare machine tool capacity. Besides dealing with "bottle necks," the centres are now able to search for capacity to fill original orders, to bring work to idle machines, and, in general, to balance out capacity. The centres are consulted by both large and small firms, and by their means orders have been obtained ranging from six to single figures. Within the last three months or so, 2000 successful contracts have been placed by capacity exchanges in the London area, although it is understood that less than 10 per cent. of the firms in the area have used them. The centres, Mr. Brabner says, can help in other matters by co-ordinating industrial welfare, the staggering of working hours, and bringing transport into line with industry. They can also help to clear some human "bottle necks." A skeleton organisation is already available which has been designed to deal with the detailed problems of ever-increasing production, and the writer expresses the hope that firms will take full advantage of the services offered by these clearing centres.

A Scottish Area Clearing Centre

It is announced that a new clearing centre for machine tool capacity has been opened in Glasgow by the Production Executive Regional Board for Scotland, whose Chairman is Sir Harold E. Yarrow, Bart. The hope is expressed that the centre may assist the war effort by ensuring that the fullest use is made of spare machine tool capacity. In every factory, it is stated, small and sometimes relatively large blocks of capacity occur in the load of individual machines, because of unbalance of plant, irregular flow of orders, delay in the receipt of materials, and other causes. Whenever such spare capacity is met with, or when it is foreseen, employers are invited to place themselves in touch with the secretary of the Regional Board, Mr. W. R. Grist, of 21, Glassford Street, Glasgow, so that steps may be taken to place the firm in question in touch with suitable work. The clearing centre, it is stated, is also in a position to render help when a firm requires assistance to manufacture some small part or perform certain machining operations, in order to reduce a "bottle neck" in the flow of its production of essential goods. The Regional Board for Scotland was, as already referred to in our Journal note of July 25th, recently enlarged, and has now direct access to the War Cabinet, through the Production Executive under the chairmanship of Mr. Ernest Bevin, the Minister of Labour and National Service.

Winter Railway Travel

Speaking in the House of Commons on Thursday, July 31st, Colonel J. J. Llewellin, the Parliamentary Secretary of the Ministry of War Transport, answering a question, dealt with some aspects of railway travel during the coming winter months. With regard to a suggestion that first-class travel should be abolished, Colonel Llewellin said that at the moment the Ministry was not disposed to take off the first-class compartments on long-distance trains, but with regard to the suburban lines the matter would be looked at very closely, and he thought that something might be done for Londoners. With regard to an announcement which had been made that sleeping cars and restaurant cars might be withdrawn, he said that there was no immediate need to do that. Those amenities of travel should, he thought, be kept on as long as it was possible to do so. If restaurant cars were to be taken off, then passengers would have to carry refreshments with them, as traffic could not be delayed while they took meals at intermediate stations. With regard to the winter travelling, he gave a warning of the possibility of difficulties. At the moment, he said, trucks were waiting at the collieries, and coastal ships at the ports, but there was no coal to carry. If the programme which had been drawn up by the Minister of Labour, the President of the Board of Trade, and the Secretary of Mines was accomplished, then the Ministry of War Transport might have the greatest difficulty in carrying the amount of coal to be transported. The Ministry, Colonel Llewellin stated, could be relied upon to do its best, but in doing its duty some of the travel facilities, perhaps sleepers, perhaps restaurant cars, and perhaps whole passenger trains, might have to be withdrawn, in order to allow all the people in the cities and the munition factories to obtain the coal they needed. Not, however, for the sake of making ourselves uncomfortable, he concluded, should we take off any of the facilities of travel.

Welsh Highland Railway

As recorded in our issue of July 25th, the Welsh Highland Railway has been purchased by George Cohen, Son and Co., Ltd., for dismantling. It is hoped that some 1200 tons of relayable rails, several thousand sleepers, and a considerable tonnage of scrap will become available for the national war effort. In a memorandum we have just received from the Liverpool and District Ramblers' Federation, the suggestion is put forward that the railway track, after dismantling, should be given to the nation as a walking route. The memorandum has been forwarded to the local authorities throughout Caernarvonshire, to Members of Parliament, and other interested parties and bodies, with the idea of arousing public interest in the proposal. We may recall that the Welsh Highland Railway was incorporated on March 30th, 1922, for the dual purpose of developing the slate quarries and mines of Snowdonia, and of affording to visitors a means of enjoying the scenic attractions of the district. In addition, the railway acquired the undertakings of the North Wales Narrow Gauge Railways Company and the Portmadoc Beddgelert and South Snowdon Railway Company, which in January, 1934, was leased to the Festiniog Railway Company. As the lines did not prosper the service was abandoned in June, 1937, since which time the track has been unused. For the greater part of its length the railway runs between open fences, beginning at Dinas, near Caernarvon, and running for 25 miles through the valleys and foothills of Snowdonia, terminating at Portmadoc. It is suggested that the few feet between the fences would be little, if any, benefit to the owners of the adjoining fields, while in other places, where the line passes close to the river and through tunnels in the hillside, the land cannot be cultivated. The proposal to convert the track into a walking route arises partly from the fact that a special way for pedestrians between the towns above named does not at present exist, and partly from the fact that in its present condition, especially after dismantling, the railway will be of little use either to the shareholders or to the public. The motor road from Caernarvon to Portmadoc is not the sort of route that ramblers would take, and the provision of an exclusive path for them would be a concession of great value. It may be recalled that in 1937 the London Midland and Scottish Railway Company gave to the nation the dismantled track of the Manifold Valley Railway, and the Staffordshire County Council undertook the work of and expense of reconditioning the track as a public footpath. If the investing authorities in the Welsh Highland Railway were to combine with the Caernarvon County Council to dedicate the grass-grown track as a public way for walkers, the Federation suggests they would make a contribution to the physical and spiritual well-being of the country, the extent of which can hardly be estimated.

Coal Supplies and Distribution

Speaking in the House of Commons on Tuesday, August 5th, Mr. D. R. Grenfell, the Secretary of Mines, gave a general review of the coal supply position and the problem of distribution and transport. He said that over 100,000 men had left the coal industry since the outbreak of the war, of whom 75,000 had gone in the last twelve months. If those men had not left the mines we should not have been faced with the shortage this year. The Government had aimed at securing 10 per cent. more production for the whole of the summer period, so that they could start next winter with a much greater stock than they had at the beginning of last winter. Progress had been made in some coalfields, and the average output per man was higher in 1940 than in the pre-war years. With all improvements in efficiency, however, there was hardly any prospect of maintaining the 10 per cent. increase in weekly output during the next three or four months without adding to the man power now at the disposal of the industry. The programme would have to be cut down. Economies had been proposed and adopted, which would have the effect of wiping out half the deficiencies which had already occurred. He (Mr. Grenfell) was glad to report that no essential works, factory, or utility service had suffered any material loss of output through coal shortage since the war began. He paid a high tribute to the work of the Committee of the Conjoint Conference of Public Undertakings, appointed by the President of the Board of Trade, which met under the chairmanship of Mr. John C. Dalton, the general manager of the County of London Electric Supply Company. The advice given by that Committee had been of great assistance in dealing with the question of coal stocks for the public utility undertakings. Speaking in the debate, Sir Andrew Duncan, the President of the Board of Trade, said that although the present coal position was one which gave cause for concern, it would be a great mistake to exaggerate it into a crisis. In spite of the fact that the target figure of production had not been reached, the truth was that at present the stocks of coal in public utility companies', railways', in industries', and in merchants' hands and Government dumps, taken together, were at least 1,000,000 tons more at this moment than at this time last year. With regard to transport and distribution, all that was possible was being done to foresee and prepare for the problems which would arise in the winter. Sir Andrew announced that Mr. Gilbert Szlumper, the general manager of the Southern Railway Company, had been asked to give his full time at the Board of Trade and the Ministry of Mines for the purpose of co-ordinating all transport problems, whether by rail, sea, or canal. Mr. Szlumper had now been at this task for several weeks. In this matter the Board of Trade was having the wholehearted co-operation and support of the Minister of War Transport, and in this respect it was a great advantage that both shipping and railways were under one Ministry.

The Control of Storage Space

In a Journal note of May 16th we recorded the appointment of Sir Cecil Weir to the office of Controller-General of Factory and Storage Premises, and the provisions of the Board of Trade Storage Facilities (Information) Order (S.R. & O., 1941, No. 641), which required the owners of suitable storage premises in Great Britain to notify the Controller and to give certain information with regard to available premises. A further Board of Trade Order just published by the Stationery Office will have a far-reaching effect on the use of factory and warehouse premises. The Order—the Location of Industry (Restriction) Order, 1941—provides that no person may, without a licence, carry on at any factory or warehouse having an area of 3000 or more feet super, any trade or business not carried on previously, or carry on at other premises having an area of 3000 or more feet super, whatever their previous use, a business of production or storage. The object of the Order, it is stated, is to facilitate provision through the Control of Factory and Storage Premises, of factory and storage accommodation, which is urgently needed for Government purposes. It does not, it is pointed out, apply to shops or to new buildings, and a general licence is being issued providing for the use of premises for temporary storage purposes without a specific licence. If, however, such premises are used, the Control must be advised in writing. Special consideration is to be given to applications by firms dispossessed by enemy action or through other causes outside their control to use neighbouring premises.

Industrial Development in India

In the course of a statement in the House of Commons, Mr. L. S. Amery, the Secretary of State for India, when presenting the estimates for India and Burma Services, on Friday, August 1st, said that the Government of India and H.M. Government were anxious to develop India's industrial and munitions production to the very fullest extent. There was no question of there being any obstruction at this end to prevent India from developing her industries. As regards shipbuilding, India's existing yards were all turning out as many craft as they could, although all the machinery had to come from Britain. They were relatively small craft, and the problem of whether India at this moment could successfully embark on the building of larger merchant ships, and whether it was possible to convey to India all the machinery and material required for economic production, was under earnest consideration. It was an entirely mistaken idea that the creation of an aircraft industry in India had been obstructed and prevented. The Viceroy had succeeded, with the help of private industry, in creating at any rate a small aircraft production industry, whose first planes were already in the air. The engines came from America. Everything would be done to develop this industry. The Government, Mr. Amery concluded, did not look jealously upon the development of Indian industry. It fully realised that the development of Indian resources in every direction—industrially as well as agriculturally—was essential to her prosperity, and as the foundation of her security and that free position in the world in which they wished to see her to-day.

Historic Accidents and Disasters

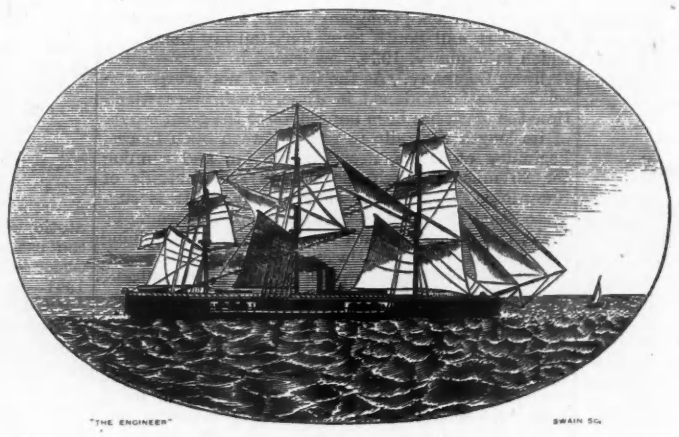
No. IV

(*Continued from page 67, August 1st*)

H.M.S. "Captain"—Part II

IT was in the unhappy circumstances described in our preceding article that the building of the "Captain" was begun. Looking at the contemporary picture of her which we reproduce herewith, we must be struck by the fact that apart altogether from any question of her seaworthiness, she was an extraordinary type of warship. She had a length of 320ft., a breadth of 53¼ft. and a draught of about 25ft. She was fitted with twin screws driven by engines of 900 H.P. In addition, she was fitted to carry 26,300 square feet of sail. The extraordinary feature of her design lay in the location of the turrets. They were situated on the main deck between a high forecastle and a high poop, while between them was the engine-room casing, the whole being surmounted by an upper deck. Each turret contained two 600-pounder guns. Forward and aft on the upper deck a single 7in. 115-pounder gun was mounted, unprotected by armour.

The "Captain" was clearly not entitled to be called either a turret ship or a monitor. Except for the 7in. guns forward and aft, she could not fire ahead or astern. The forward turret could be trained to fire at a maximum of 64 deg. forward from line abeam. The extreme safe limit for the after turret was 70 deg. These figures compared with 30 deg. for 250-pounder guns mounted on existing broadside ships. During May, 1870, the "Captain" went to sea with a squadron commanded by Admiral Symonds, and carried out gunnery trials. The forward turret guns were fired at angles up to 60 deg. Admiral Symonds decided not to fire them while trained beyond that angle, for he held that any firing at extreme angles should be done only when the ship was near a dockyard which could render speedy aid in the event of damage being down to the forecastle. There is no evidence to show that the guns of the after turret were fired during the cruise. Admiral Symonds had intended that they should be tried, but Captain Burgoyne requested that they should not be fired because to do so would inconvenience some members of the ship's company in the sick bay, which was badly placed relatively to the guns.



H.M.S. "CAPTAIN"

The "Captain," it will be gathered, did not possess that all-round field of fire which should characterise the true turret ship. Her range of fire was, in fact, not much more than twice that of a broadside ship. In addition, all her top hamper was unarmoured, and as both Mr. Reed and Admiral Symonds pointed out, might, in an action, collapse on to the turrets and render the guns useless. Discussing the disposition of her guns, Admiral Symonds described the 7in. weapons on the upper deck as affording only apologies for bow and stern fire. As for her turret guns, he wrote in his report: "A vessel armed as the 'Captain' cannot advance end-on in line abreast with other ships and fire shot in line of advance without danger of collision." Mr. Reed's comment on the gun disposition was that the "Captain" was "the only ironclad ship built of late years for the British Navy which cannot fire a gun ahead or astern from behind armour."

The ship not only lacked the true characteristic of a turret ship; she also lacked the prime characteristic of a monitor. Ericcson's "Monitor" had a freeboard of 5in The "Captain" had a designed freeboard of about 8ft. Even although this dimension had been sufficient to secure the reduction of visibility which was the chief aim of the "Monitor's" design, the designer, or designers, of the "Captain" threw away that advantage by piling a high forecastle and poop, an upper deck, a funnel, and three masts on top of the main deck. She, in short, presented a target as big as any broadside ship of the same tonnage.

In general terms, we might justly describe the "Captain" as a broadside ship stripped of her armouring down to within 8ft. of the water line, with her waist cut down to the same level, and with four guns on her main deck capable of firing on either side through a training range approximately twice as large as that of the guns in an ordinary broadside ship. It is quite evident that had Mr. Reed felt no uneasiness about the ship's stability when under sail, he would have had ample grounds for disapproving of her solely on the score of her characteristics as a fighting ship.

We have said that her designed freeboard was about 8ft. After she had been launched and prepared for sea, her actual freeboard was only about 6ft., and that, too, with but 500 or 600 tons of coal in her bunkers instead of the intended 1100 tons. It is not possible to give the true explanation of this obviously vital characteristic of the ship as built, the "grave departure from her original design" to which the Court of Inquiry referred in its report. Contemporary statements on the point are at variance with one another. According to one statement, the weight of the ship had been miscalculated to the extent of 800 or 900 tons. According to another, the intended weight was exceeded by the deliberate action of Laird Brothers, who, while the ship was being built, increased her scantlings in order to provide what they deemed to be a necessary increase in the strength of her hull. A third statement suggested that the extra weight was to be attributed to the introduction of nearly 800 tons of water ballast into the compartments between the two skins of the hull. Her builders, it was said, knew she was a crank ship. The water ballast, it was suggested, was added to increase her resistance to rolling, even, perhaps, to keep her upright at all in the water. No satisfactory light on this point was forthcoming during the Court's inquiry. Yet one would have thought that an excess in the weight of the hull of some 25 per cent. over the intended or designed weight would have been a subject into which the Court would have instituted the closest inquiry.

On one feature of this discrepancy it is possible to speak with complete assurance. The fact that the "Captain" floated 2ft. deeper than was at first intended was fully known long before she sailed on her last voyage. In a letter published in *The Times* on August 6th, 1870—a month before the disaster—Mr. Reed wrote: "Her side is 6ft. high and would have been 8ft. but for an alarming blunder in calculation—the worst that I have ever known."

Complete loyalty to the editorial views expressed in our columns seventy-one years ago would require us to-day to hold up Mr. Reed as the villain in the tragedy of the "Captain" and "poor Captain Coles" more or less as the hero. Try as we will, however, we cannot make it work out quite in that way. Up to this point in our story we have found Mr. Reed behaving consistently and in a manner which must command modern scientific respect. The ends of poetic justice, we feel, would be served if we were now to dismiss him from the narrative and bring forward his successor and former assistant, Mr. Barnaby. Responsibility for the sombre events which remain to be related cannot, however, be wholly transferred in this manner from the one man to the other. It is undoubtedly true that while Mr. Reed was still in office he failed to take steps which would almost certainly have resulted in the disaster being avoided. The fact that Mr. Barnaby at a later date also neglected an opportunity of avoiding it does not excuse Mr. Reed from the consequences of his earlier inactivity.

Jointly or separately, Mr. Reed and Mr. Barnaby must be held responsible for the fact that on August 4th, 1870, the "Captain," fully manned, left Portsmouth on her third and last cruise in a condition as regarded her stability which was dangerous, which it was their duty to know and to report as dangerous, and which Mr. Barnaby at least, with the data available and within the time at his command, could readily have established as being dangerous.

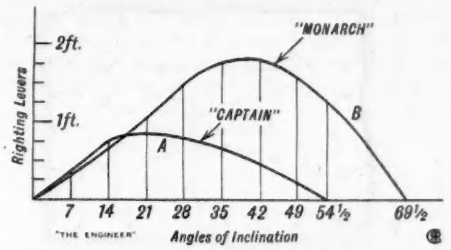
It is quite certain that Captain Coles had abundant but unfounded confidence in the stability of the ship. Laird Brothers, however, seem to have had some doubts on the subject. In February, 1870, after the "Captain" had left their yard and been delivered to the Admiralty for trial, they asked that the ship should be inclined in order to ascertain her "true centre of gravity." The request was not acceded to, Mr. Reed holding that it was preferable to proceed with the ship's engine trials and postpone the stability tests until better weather arrived. The inclining trials were actually postponed until July 29th, six days before the ship left on her last and fatal voyage. The trials were conducted by Mr. Barnes, one of Mr. Barnaby's assistants. Six days were available for working out the calculations from the data provided by the experiments, six days within which to stop the sailing of the ship, and more than six days within which to recall her. These days were allowed to slip away. It was not until August 23rd that the calculations were completed and the ship's centre of gravity and metacentre were known. A fortnight yet remained before the fatal day, but nothing was done. "When the calculation was completed, we," Mr. Barnaby testified, "saw nothing in it to cause us to apprehend, in the face of the reports of the officers who had tried the ship at sea, that she was in danger of capsizing." Nevertheless, the stability curve showed that at an inclination of 14 deg. the edge of the ship's deck would be immersed, that maximum stability, corresponding to a righting moment of 7100 tons-feet, would be reached at an inclination of 21 deg. and that at an inclination of 54½ deg. the righting moment vanished.

That the "Captain's" stability curve did not cause Mr. Barnaby and Mr. Barnes any apprehension is almost incredible, unless we suppose that having drawn it, they preferred to trust "the reports of the officers who had tried the ship at sea" rather than the evidence of the curve. Alternatively we may suppose that they had no means or opportunity of comparing the "Captain's" stability curve with that of another ship of similar size. The "Monarch" was such a ship. Can we believe that she, too, was sent to sea without her stability being determined? If the "Monarch's" curve was available and if the "Captain's" had been compared with it, there would have been no grounds for complacency concerning the safety of the "Captain." The curves for the two ships reproduced herewith are taken from Attwood's "Theoretical Naval Architecture."* They show that the "Monarch's" righting moment increased up to an angle of heel of about 40 deg. and did not vanish until 69½ deg. was reached. In addition, the magnitude of the maximum righting moment for the "Monarch" was more than twice that for the "Captain." The "Monarch" had actually a greater righting moment at 60 deg. than the "Captain" had at 21 deg.

Why did Mr. Reed, Mr. Barnaby and Mr. Barnes act as they did in this grave matter of the "Captain's" stability? We may dismiss at once as childish the excuse which was advanced that the calculations involved in determining the ship's stability curve from the data obtained from the Portsmouth heeling trials were exceedingly laborious and occupied much time. That excuse does not satisfy us to-day any more than it satis-

* The curves show the righting, or GZ, levers at different angles of heel, that is to say, the horizontal arm of the couple constituted by the downward weight of the ship and the upward buoyancy of the displaced water. The righting moment at any angle of heel will be the displacement of the ship multiplied by the value of the righting lever. The displacement of the "Monarch" was somewhat greater than that of the "Captain."

fied competent people at the time it was made. Two days, not twenty-four, should have been ample for the work. In any event the delay in determining the stability curve after all the data for its calculation had been accumulated is only one item in the general total of indifference towards the ship displayed in the Naval Constructor's department. That indifference seems far too studied to permit us to assign it to pure carelessness and we know better than to trace it to professional incompetence. Regretfully we are forced to the only explanation which will fit all the facts—pique and jealousy originating with Mr. Reed.



STABILITY CURVES OF THE "MONARCH" AND THE "CAPTAIN"

From the first he and Admiral Robinson disapproved of the design and specification of the "Captain" and in our view they had very good technical reasons for their disapproval. The Board of Admiralty rode rough-shod over their advice and ordered the "Captain" to be built. It held, so Mr. Reed averred during the course of the inquiry, that the views on the subject expressed by Admiral Robinson and himself were not to be trusted and that they were animated by prejudiced opposition to Captain Coles. Whether the Board really did hold this opinion or not there is no confirmatory testimony, but Mr. Reed believed that it did. Human nature being what it is, the seed of jealousy was sown. We can catch glimpses of its ripening while Mr. Reed was still in office and of its being passed on in full flower to his successor, his one-time assistant, still loyal to his old chief, but now embarrassed by his inheritance from him.

It would be a crime against the memory of Mr. Reed if we did not add one further word in explanation of his conduct. He stood aside during the earlier stages when by express order of the Admiralty he was to be relieved of all responsibility for the design and construction of the "Captain." He continued to stand aside during the later stages when, holding the opinions which he did, he ought to have intervened, orders or no orders. It was not cowardice which rendered him inactive. It was a pardonable miscalculation of the probable course of events. He believed, and doubtlessly he passed on his belief to Mr. Barnaby, that the "Captain" would reveal her inherent instability during the course of her first few voyages and that she would speedily be condemned and relegated to the scrap heap. He did not foresee that the demonstration of her instability would proceed to the length of a calamitous disaster.

Such is the story of the "Captain" as we read it to-day. It has not been an easy task to tell it fairly to all concerned. At almost every point we have had to guard ourselves against the influence of those factors which we mentioned at the outset. Among those factors, the partisanship of *The Times* in Captain Coles' favour and—we need not hide the truth—the animosity towards Mr. Reed expressed in our own columns were prominent.

(To be continued)

Some Notes on Tunnelling Practice

By ROLT HAMMOND, A.C.G.I., Assoc. M. Inst. C.E.

IN tunnelling through rock three main factors come into play: efficient and economical use of explosives; length and disposition of shot holes suitable for any particular ground; and the rapid removal of shattered rock. In short, tunnelling through sound rock, which does not call for supporting timbers or steel ribs, resolves itself into a matter of careful organisation and planning.

No hard and fast rules can be laid down regarding the resistance of rocks to blasting; much will hinge on the thickness of each stratum and the presence or otherwise of jointing and faulting in the rock. As a rough guide, compressive strengths of the main rock types can be classified in the following descending order:—Basalt, granite, slate, shale, coal and chalk. Although limestone has a lower strength than either basalt or granite, by reason of its homogeneity it may require heavier charges to break it up; conversely, basalt and granite may be so heavily fractured by bedding and jointing that comparatively light charges will suffice.

Explosives for mining and tunnelling work vary from slow-burning gunpowder to high explosives which detonate, the latter being classified as gelatines and dynamites; gelignites and straight dynamites are classed according to their nitro-glycerine content, the percentage of which is 62 for gelignite and 60 for Glasgow dynamite. In the case of ammonium nitrate gelignites the percentage of nitro-glycerine is designated by figure only, such as A.N. Gelignite 60, this figure representing the percentage of nitro-glycerine in the equivalent ordinary gelignite. For drifting and tunnelling in very hard ground blasting gelatine should be employed.

Delay action electric detonators are widely used nowadays for shot firing, and Fig. 1 shows a gasless detonator of the type made by Imperial Chemical Industries, Ltd. It consists of the detonating charge, delay element and fuse head; being carefully sealed, the absence of gas from the delay composition ensures that the burning speed of the element is not affected by outside influences. The normal time interval between each set of delays is one second.

Electric firing should always be used for firing a number of shots, since with safety fuse there is always the possibility, by no means remote in so far as the author's experience goes, that the shot firer may take longer than he intends to light the fuses, with the result that the shots may go off before he has finished lighting the complete round. Such a dangerous condition may arise from the bad practice of cutting fuses in order to attain the same result as using delay electric detonators; this practice should be vigorously discouraged.

Safety fuse should therefore be used only for

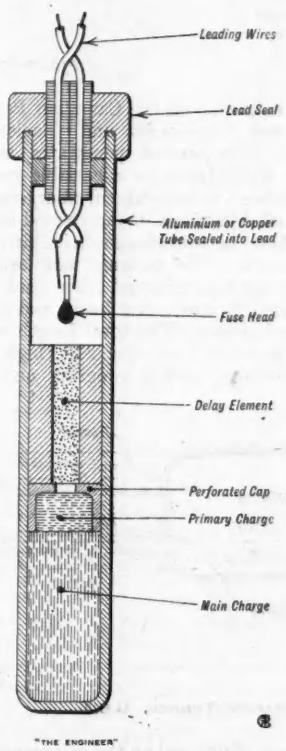


FIG. 1—GASLESS DETONATOR

firing individual charges and pop shots. It consists of specially prepared gunpowder enclosed in surrounding layers of jute and cotton yarn; the average burning rate is 90 seconds per yard. There may be occasions when the firing of a number of shots by safety fuse is unavoidable, and then Cheesa sticks or fuse lighters should always be used. A fuse lighter consists of an igniting material contained in a shellac paper tube; it burns with an intense flame for a definite length of time. It is thus possible to limit the number of holes lit by the shot firer, or the time spent in the operation. This also ensures that the shot which is first lit does not detonate before the last one is lit; the flame is very hard to put out, even in very heavy wind or rain.

This device is, of course, open to abuse. On one occasion the author saw a shot firer preparing to light a number of safety fuses, with a row of Cheesa sticks in his pocket. The man carefully explained that he proposed to light a new Cheesa stick, if the first gave out before he had lit all the fuses thus defeating the very object of using this method.

When firing a number of shots electrically it is always advisable to use an exploder having a capacity considerably in excess of that actually needed. For example, when testing an exploder having a capacity for firing forty shots, it is usual

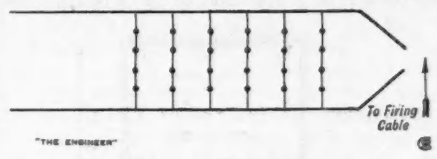


FIG. 2—PARALLEL-SERIES CIRCUIT

to employ a testing resistance with a capacity of eighty shots, thus providing a factor of safety of two. Great care should be taken when connecting a number of electric detonators, and the complete circuit should always be tested with a galvanometer before firing. It is also essential that all connections should be the responsibility of one man. It is possible for a large number of shots to be unexploded, as a result of this divided responsibility.

A simple series circuit is usually employed, one wire from each detonator being connected to one wire of the next detonator, thus forming a continuous circuit, the remaining two unattached wires being connected to the shot firing cable or "leading wire"; the last connection made should be between the exploder and the cable. Since the former is generally designed for firing a specified number of shots, calculation of voltage required is not necessary; in any case it is merely a matter of applying Ohm's law.

On many tunnelling works it may be convenient to fire from power or lighting lines, when a current of from 0·5 to 0·7 amperes should be allowed for each detonator. For example, with a round of thirty detonators in parallel, each having a resistance of 2·75 ohms, the combined resistance will be 0·09 ohms. With a 100-yard cable having a resistance of 5 ohms the total resistance is therefore

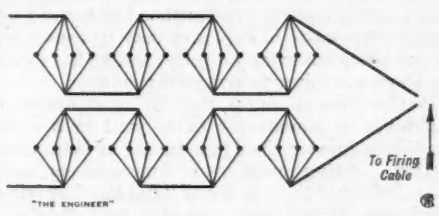


FIG. 3—SERIES-PARALLEL CIRCUIT

5·09 ohms; total current required is thus 0·5×30 or 15 amperes. This gives a voltage of 15×5·09, or about 80.

The parallel-series circuit, shown in Fig. 2, is recommended only for firing from a mains supply; it is not suitable for use with an exploder. The sketch shows that each series circuit consists of four electric detonators and that there are ten such series; assuming the length of the wire to be 30ft. of copper, and that 100ft. of connecting wire and 100 yards of shot firing cable are needed, calculation of the voltage is as follows:—

Each series will require 1·5 amperes, giving a total of 15 amperes; the resistance of each circuit of four detonators will be 11 ohms, since each detonator has a resistance of 2·75 ohms. Total resistance of the circuit will be the resistance of each series divided by the number of series, or 1·1 ohms. The resistance of the connecting wire is 1·3 ohms and of the shot firing cable 5 ohms; the total circuit resistance is therefore 1·1 plus 1·3 plus 5, equal to 7·4 ohms. Voltage required is thus 15×7·4, or 110 volts.

The series-parallel circuit is shown in Fig. 3 and this is also suitable for mains current. Assuming similar conditions to those obtaining in the last example, the resistance of each parallel circuit

will be 2·75/4, or 0·66 ohm. Resistance of the ten parallel circuits will thus be 6·6 ohms, and the total resistance of the circuit 12·9 ohms. Current required in each parallel circuit is 0·7×4, or 2·8 amperes, and the corresponding voltage is thus 12·9×2·8, equal to 36·12 volts, very much less than in the parallel-series circuit.

The direction and depth of the shot holes in a tunnel or heading are dependent upon local conditions and only experience and experiment will decide the best arrangement. A good example of the lay-out of charges in a small heading is given by Fig. 4, taken from "Blasting Practice," an excellent little text-book published recently by Imperial Chemical Industries, which indicates the general principle of blowing out a wedge or pyramid-shaped portion in the centre, followed by "easers" and "trimmers" outside. The centre shots are known as "cut holes," and these should generally be aligned by a "hole director," so that they intersect as shown in the sketch. Such a hole director can be easily knocked up of odd pieces of

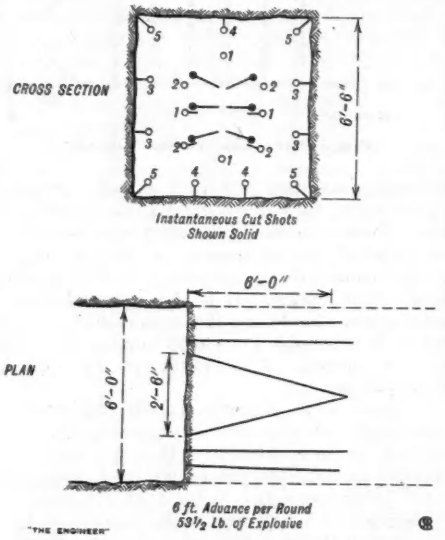


FIG. 4—LAY-OUT OF CHARGES

scrap metal or tubing, and the author has found this device to be invaluable.

The heading shown was driven through schist, the total quantity of explosive for a 6ft. advance amounting to 53½ lb. Cut holes were instantaneously fired, and the other numbers indicate the firing order of subsequent shots; the charge in the cut holes was 21 lb. Total explosive consumption amounted to about 7 lb. per cubic yard. In hard rock it is often a good plan to charge and fire the cut holes first, and then to charge and fire the easers and trimmers. The author has found that considerable waste of explosive may be caused by the cut shots not firing properly, and he has found the above procedure to give good results.

It is obvious, of course, that the consumption of explosives in pounds per cubic yard in a small heading is greater than in a tunnel of large cross section. During recent years American engineers have developed the practice of "full face" driving, employing drifter drills mounted on "jumbos" or drill carriages. A typical example is found in the new Delaware aqueduct for the water supply of the city of New York. Here an average round for the 23ft. diameter heading amounted to seventy-nine shot holes; cut holes were 13ft. deep, easers and trimmers having a depth of 11ft. The total charge comprised between 500 lb. and 600 lb. of Hercules Gelamite No. 1 explosive; this gave an average advance of about 9ft., resulting in an average explosive consumption of 3½ lb. per cubic yard.

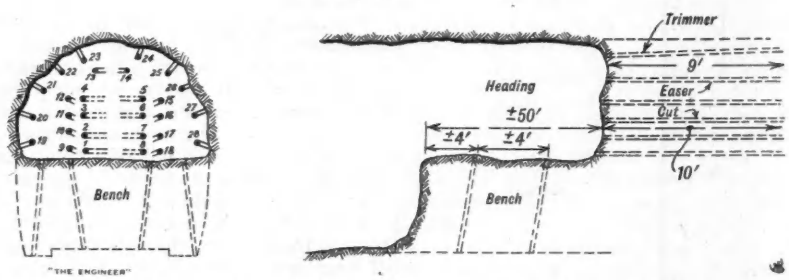


FIG. 5—SHOT FIRING DIAGRAM FOR SHANDAKEN TUNNEL, U.S.A.

The total length of shot holes drilled in a period of 2½ hours was 725ft., which resulted in an average drilling speed of 31ft. per hole for each drill. The cut holes were fired instantaneously and seventy-three electric detonators were used for exploding the charge.

Let us now consider some typical examples of rock tunnelling in various parts of the world. In the case of the Shandaken tunnel, U.S.A., driven through grey and red sandstone, interspersed with blue, red and green shales, both the full face and heading and bench method of excavation were employed. This tunnel has a total length of 95,740ft. (18·1 miles) and nearly half of it required timbering; the finished cross section is of horse-shoe shape, 11ft. 6in. high and 10ft. 3in. wide. Dynamite of 60 per cent. and 40 per cent. strength was used, and the depth of shot holes was from 10ft. to 12ft. in the heading and 6ft. in the bench; average pull of a round was 8·5ft. The maximum progress per month in the twelve headings was 6040ft., and explosive consumption was 4·6 lb. per cubic yard, when using the heading and bench method and 3·4 lb. with a full face heading.

Another work of considerable interest was the Boyati tunnel, which forms an integral part of the water supply of the city of Athens; it connects the first century aqueduct of the Emperor Hadrian with the Marathon reservoir, impounded by the famous Marathon dam. This tunnel was driven through hard-breaking marble, its dimensions being 7·38ft. high and 8·86ft. wide; the depth of shot holes averaged 8·5ft. and the average pull per round was 7·5ft. The tunnel has a total length of 8·3 miles.

When we come to tunnels of large cross section many different constructional methods have to be adopted, according to the local ground conditions. An excellent example of a double-track railway tunnel through hard ground is provided by the Rogers Pass tunnel on the Canadian Pacific Railway between Connaught and Glacier, British Columbia. This tunnel penetrates schist and quartzite, which broke in a variable manner. A centre heading was first driven, enlargement to the main tunnel dimensions being carried out by two series of shots, bottom charges being fired ahead of upper charges. The columns and arms of the drills were set to engineers' lines, each shot hole being aligned by clinometer board and drilled to a prearranged depth. The total length is 5 miles, the final cross section being 24ft. high and 26ft. wide. Average weekly progress on the main heading was 870ft. and on the enlargement 1030ft.; the last 4 miles were excavated in one year, the whole job taking about three years to complete.

Another example of hard ground tunnelling is provided by the Shimizu tunnel on the Japanese State Railways, driven through very tough-breaking diorite. In this case a bottom heading was first driven; this was then enlarged at the sides, followed by a centre section and the arched section above it. This tunnel has a total length of 31,832ft. and is reputed to be the longest in the Orient; it was completed in about six years.

The Galerie d'Erronville, a mine railway tunnel driven by the Société Minière des Terres Rouges, is of considerable interest in that liquid oxygen was employed as a blasting medium. Cartridges were made up of sawdust, aluminium and magnesium powder, the mixture being impregnated with oxygen and fired by electric blasting caps in the same manner as dynamite. This tunnel is 9ft. 10in. wide and 9ft. high and has a total length of

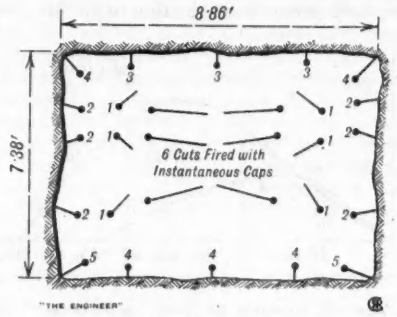


FIG. 6—SHOT FIRING, BOYATI TUNNEL, GREECE

14,760ft.; a full face method of drilling shot holes was employed, the average pull per round being 4·3ft. An average weekly progress of 82ft. was maintained.

Shot firing diagrams for these five tunnels are shown in Figs. 5 to 9 inclusive, compiled from information contained in "Rock Tunnel Methods," published by the Hercules Powder Company.

Excavating a tunnel of large cross section in soft or broken ground presents a problem of no

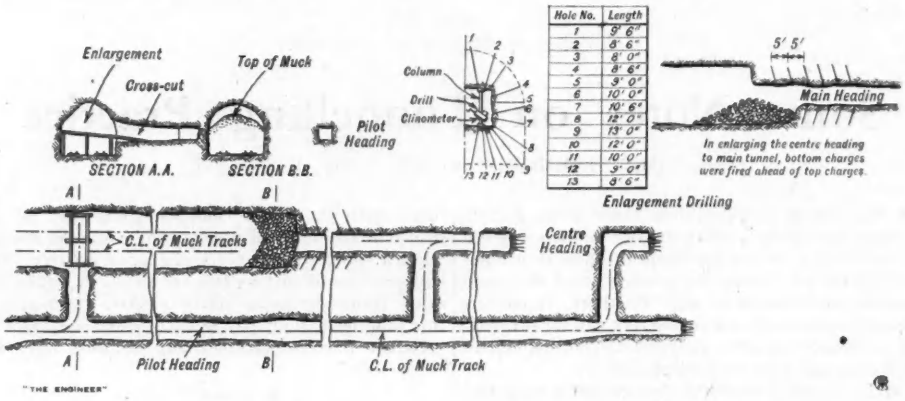


FIG. 7—ROGERS PASS TUNNEL, C.P.R.

mean difficulty. British practice generally favours the "bar and cill" method, a short description of which may be useful, together with a few notes from the author's experience of this type of work. Figs. 10 to 15 show successive stages in excavating a double-track railway tunnel. In the first place a bottom centre heading and two side headings are driven for the full length of the tunnel, the ground being supported either by steel mine arches or by timbering. Then a number of shafts are driven up from the centre heading and, if ground conditions are reasonably favourable, a top heading may also be driven; if this can be done it is an advantage, since it gives a good idea of the ground conditions likely to be encountered when opening out the arch.

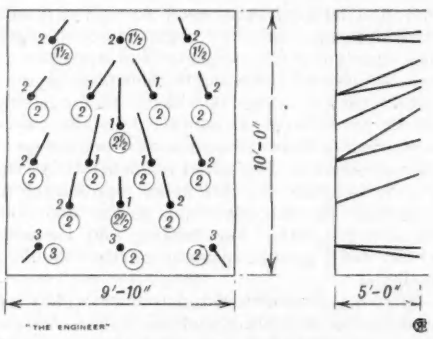


FIG. 8—SHOT FIRING, SHIMIZU TUNNEL, JAPAN

In the case of a very long tunnel it may be an advantage to sink shafts from above, in order to increase the number of working faces and thus to speed up the work. Fig. 10 shows the crown bar and the bar on each side supported by props on a

small cill in the top pilot heading. The next stage, shown in Figs. 11 and 12, consists of opening out the arch to the full cross section. The initial bars are first propped on the "nipper cill," after which the main cill is placed in position and the remaining props and bars erected.

In a tunnel of this size the main cill would probably be made up of 14in. by 14in. timbers joined together by a capping piece. Props can be either 9in. by 9in. timbers or trees of between 9in. and 12in. diameter; the bars would be rolled steel joists of 10in. by 5in. section, but these dimensions would largely depend upon ground conditions. These bars should be set at such a height that the minimum area of ground is taken out, to allow for the full section of arch and for the packing between the extrados of the arch and the poling boards. If the boards can be removed, well and good, but it is often impossible to do so, and sometimes entails risks which far outweigh any possible advantage gained by removing the timber.

When opening out an arch section of this size it is most important to make sure that a benching is provided, more particularly in soft or broken ground, as shown in Fig. 11. This ensures that the ground will be held while a new bar is being erected; the exact position of each bar should be set out on a board nailed temporarily to the props. By this means the correct profile of the arch excavation is thus carried out.

It cannot be too strongly emphasised that every effort should be made to avoid overbreak as much as possible, especially in tunnels of large cross section. In many cases excessive overbreak can easily be avoided, and is more often than not due to the unwise and even reckless use of explosive. Where the ground is very blocky, overbreak is often unavoidable, but should a cavity be formed in soft or finely broken ground, it may be extremely difficult to pack it efficiently. Packing should either be in the form of timbering laid in criss-cross fashion, or should be composed of rock spalls; in any case, the packing of a tunnel of any considerable size should always be grouted, great care being taken to ensure that this grout does not block the drainage system.

Figs. 13, 14 and 15 show the finishing stages of pouring the side walls and turning the arch, which are assumed to be of concrete and brickwork respectively. Vibrated concrete is now employed extensively for tunnel lining, both in the form of pre-cast segments and internally vibrated. Pumped concrete is also widely used, a good example being provided by the 2 cubic yard capacity Rex Pumpcrete machine, used with telescoping steel forms, in the West Coachella tunnels of the Colorado River aqueduct, U.S.A.

The choice of lining will largely depend upon local site conditions. In the case of the La Quiebra railway tunnel at Antioquia, Columbia, South America, having a length of 12,280ft., the side walls are of stone masonry and the arch is of concrete. From a lining point of view the St. Paul Pass tunnel, on the Chicago, Milwaukee and St. Paul Railroad, is of considerable interest in that it was temporarily timbered and later concreted by the railway company after having been opened to traffic. The timber lining consisted of a five-segment arch comprising 12in. by 12in. timbers with 3in. poling boards; in some sections the large timbers were placed solid. In the Cascade tunnel the concrete lining has a minimum thickness of 24in. in the arch and 12in. in the side walls; eight travelling concrete plants placed 264,000 cubic yards of concrete in the 41,152ft. of tunnel, which was completed in about four years. Collapsible steel formwork was used, each set of forms being 37ft. 6in. in length. Concreting operations were generally carried out at a distancee of from 1000ft. to 2000ft. from the working face. The Galerie d'Erronville was lined by cement gun throughout its length.

Where plenty of skill is available the author favours brick lining, but he believes that in many cases tunnel linings are too thick, and that their main function should be to check any tendency of the ground to move. For that reason it is vitally important to erect the lining as soon as possible after excavation in certain types of ground. For example, in shale tunnels the air is liable to cause considerable disintegration of the rock. Shale is notoriously unreliable, as the author knows from his own experience, wet shale in particular being comparable in every respect to muddy clay. He has been through ground of this type in Spain, where the heading was close timbered with head and side trees of about 12in. diameter; the dimensions of the heading were about 8ft. high and 6ft. wide. In spite of the fact that close timbering was used, and that the frames were braced both vertically and horizontally, ground pressure developed to such an extent that the timbers were crushed and the floor of the heading rose appreciably. This difficult section was negotiated by making the concrete lining very thick and all the timber was left in the ground.

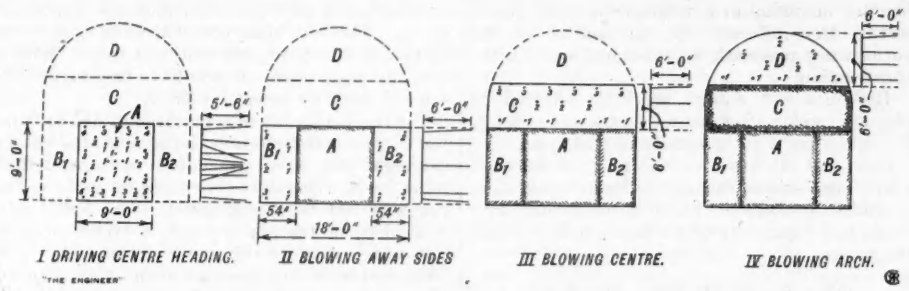


FIG. 9—SHOT FIRING, GALERIE D'ERRONVILLE MINE RAILWAY TUNNEL

There are many cases, such as mine railway or drainage tunnels at deep levels in sound rock, which do not need any lining. Where there are joint planes or any sign of crustal disturbance having affected the rock, some form of lining should be adopted. An outstanding example of what can happen with an unlined shale tunnel is proved by the case of the Galo Tara tunnel on the Khyber Railway.* Here the pilot tunnel was driven through very hard slaty shale. Dip and strike being favourable, it was decided to enlarge the tunnel to the full section for the single line of 5ft. 6in. gauge without timbering the roof. All went well, except in one place, where the roof caved in during the enlargement of the heading. Here a pocket of soft shale overlay the hard shale resulting in the formation of a large domed cavern. Attempts to timber this cavern failed, which was enlarged to such an extent that daylight was visible 70ft. above. Movement continued until the shaft so formed was stabilised.

With great difficulty this section was taken through by cut-and-cover methods, the tunnel arch being covered with a 20ft. cushion of earth. The sides were left unlined, with the result that a year later, following a great rainstorm, one side of the tunnel collapsed; a length of 20ft. of tunnel arch was destroyed. The sides of the resulting crater were supported by flying masonry arches, a difficult and expensive operation at the best of times, but more especially in such a wild and desolate region as the Khyber.

* "The Khyber Railway," by Victor Bayley, C.I.E., M. Inst. C.E., Min. Proc. Inst. C.E., Vol. 222, page 15.

Another striking example of what may happen in shale is illustrated by the Michni tunnel on the same railway. This penetrates a steep ridge of shale, which at the time of construction gave no external sign of containing water. As soon as heading driving started, however, a serious state of affairs was revealed. This portion of the tunnel consisted of wet, muddy shale, which was somewhat surprising. It was believed that the tunnel passed through an underground reservoir, a theory later proved to be a fact by vigorous drainage down the 1 in 25 gradient during the four years of construction. Fortunately, the bad portion of the tunnel was only 800ft. long. This was lined completely with an invert, consisting of six or seven rings of brick set in cement mortar.

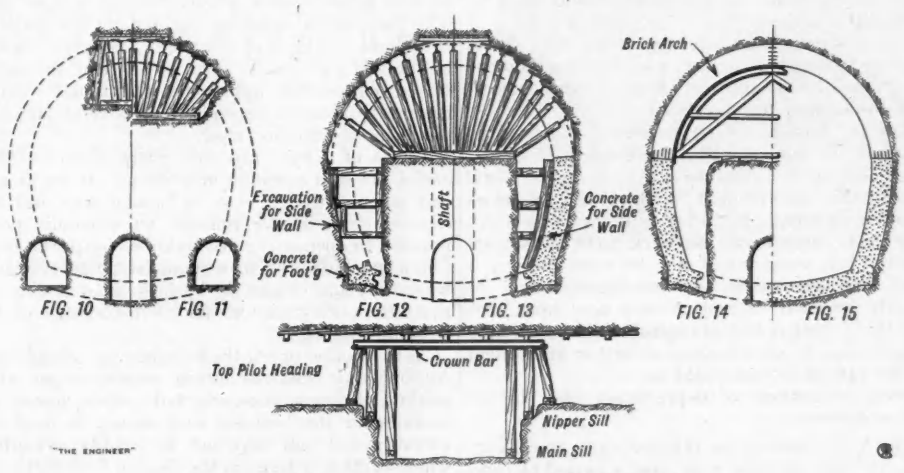
Safety is a vitally important factor in all tunnelling operations, for speed is directly dependent upon it. American engineers study this matter very closely and often appoint "safety engineers" on large tunnel works. A good example of how new safety methods may be evolved as a result of experience, combined with careful study, is provided by the Rondout–West branch tunnel of the Delaware aqueduct. Here an ingenious air-and-water spray was devised for "gassing out" the heading after shot firing.† This simple idea comprised a 3ft. length of 3in. diameter pipe, flattened at one end and provided with an opening 4in. long and ¼in. wide. This pipe was bent through an angle of 30 deg. at a distance of 12in. behind the opening. A 1in. diameter pipe was welded to this larger pipe at a distance of 6in. from the nozzle.

Just before shot firing this spray, known as the Underwood spray, was mounted 100ft. back from the face. The smaller pipe was joined to a high-pressure water line, the larger pipe to a swivel on the compressed air main. Water and air pressures, being 75 lb. and 100 lb. per square inch respectively, resulted in forming a spray curtain for the full width of the tunnel. When the exhaust fan in the shaft sucked air from the heading, this spray cleaned the atmosphere thoroughly.

A recent article published in the *Delaware Water Supply News* described how there was a complete absence of carbon monoxide, combustible gas, smoke, or fumes after five minutes. The miners were able to return to the working face fifteen minutes after shot firing. Proof that this device accelerated progress is given by the fact that the rate of tunnel driving increased with increasing distance from the shafts, the reverse of what usually occurs. Such a device more than justifies its adoption.

Even from this brief review of a vast and fascinating subject it will be appreciated that each tunnelling problem will have to be studied on its merits. So much depends upon local conditions that it is impossible to lay down hard and fast rules. For example, the author has frequently experienced a sudden change of ground in tunnel driving, necessitating complete change of method. It can, however, be definitely laid down that the essential need is to "hold the ground," for once a "run" starts, it is extremely difficult to control. The obvious corollary to this is that speed and safety are synonymous terms. In other words, the speed at which a tunnel can be driven depends more upon the speed at which the lining can be erected than upon the speed of excavation. A long stretch of unlined heading in difficult ground may well cause more trouble than it is worth.

† "New York's Water Supply," article by the author in *Civil Engineering* for April, 1941.



FIGS. 10 TO 15—EXCAVATING DOUBLE TRACK RAILWAY TUNNEL

The author dares to predict that in post-war reconstruction we shall see a great deal of tunnel work carried out. Careful study of what has already been achieved, and of how many great problems have been successfully solved, is therefore very important at the present time. Furthermore, wartime experience of tunnel works may well be usefully applied to the demands of this new era, in which economy of construction will be the guiding factor.

Depreciation of Industrial Assets

(Contributed)

No. I

Introduction and Definitions

WHEN capital is invested in machinery and in other assets as well—these being subsidiary in the present article—there are certain risks of loss by :—

(1) Heavy " wear and tear " due to running the plant or machine.

Where the machines are running for twenty-four hours every day, on high production rate, the " wear and tear " is high.

It is important that this heavy rate of depreciation should be provided for adequately.

(2) The machinery being rendered obsolete due to the appearance of a new invention of a machine or process.

This phase of depreciation is termed obsolescence and is much more difficult to provide for than under " wear and tear," which is really physical wearing out.

No one ever knows when a new machine or a new process may be invented or discovered which will have a very marked bearing upon production costs. Scientific research goes on day after day and some day a great discovery is made.

Capital is employed to purchase assets—buildings and machinery—which in their turn produce an income, but in producing that income the machinery wears itself out in the process. Factory buildings continue for years, unless they are found to be inadequate, as the business expands. Often machinery is found to be inadequate, too, and has to be replaced by more powerful and productive units.

So, in order to provide for the day when the machinery will have worn itself out and must be replaced, it is the custom to set aside a portion of the profits each year, say, for seven, ten, fifteen or more years, so as to form a kind of replacement fund which can be utilised when it becomes necessary to purchase new machinery.

Loss of Capital or Depreciation.—Now, if no provision be made for the depreciation of assets, larger dividends could be paid to shareholders. If by this improvident method the investors received dividends of 25 per cent. every year for four years, they would get back their full investment. But they would not be very pleased if they discovered that new machinery would be shortly required to replace that now worn out, and that a fresh outlay of capital would be required to purchase it, necessitating a further investment on the part of the shareholders.

Some definitions of depreciation may be set out as follows :—

(1) A shrinkage in the value of plant, machinery, &c., through physical wear over a period of time.

This decrease in value each year is usually provided for by keeping back a percentage of the profits ; this is not distributed as dividend, but retained in the business.

(2) Plant, machinery, equipment, &c., when bought, represent an expenditure of capital. Their shrinkage in value then represents a shrinkage of capital in the concern.

Those who are at the head of the factory must make some provision to meet the loss. On one side, the machinery loses value each year ; on the other side, the business organisers keep back a portion of the profits to try and balance this loss.

(3) Depreciation in value is permanent ; a seven-year lease does come to an end. The useful life of a machine will also come to an end, but you cannot tell when ; experts can give you an estimate of its useful life.

Depreciation then represents continual wastage—slow in the first two years, more rapid in the next two, and very rapid in the last two, taking a six-year period.

The rate of depreciation varies greatly. Boilers depreciate rapidly—more rapidly with careless use. Chemical plant is affected greatly by the manufactured product in the process work—often affected by the action of the various raw materials on the metal used in the construction.

Dynamos and motors are little affected by physical wear after many years of running. Electrical units are generally of this type.

Care and attention on the part of the engineers—also skill of the mechanics in repair work—tend to prolong the life of these assets. Prevention of damage is better than the best repair technique.

The " Straight-Line " Method

This method is given first because it is best understood and more widely applied than any other. It appears to be ideal for all small units of machinery, and, if we except the handicap that new calculations have to be made for each new addition, we might add that the method is readily applied.

We have three factors to consider, as :—

(1) Original cost—say, £1000.

(2) Estimated length of useful life—say, ten years.

(3) Scrap value or break-up value—say, £100.

This means that in a period of ten years' working of the asset the sum of £900 is lost ; therefore if we set aside the sum of £90 each year for ten years we accumulate in the business the sum of £900 to balance this loss.

This is also known as the " equal instalment " method.

Actual depreciation is rather different from the method shown above, simply because it does not take place at an equal rate throughout the period. It is light in the first few years and very heavy in the last two years. But in the end the estimated depreciation approaches the actual. How near it approaches depends upon several factors, one being the method used.

Length of Useful Life and Scrap Values.—The useful life of a machine may be said to be at an end when, through cost in breakdowns and in repairs, it no longer remains an economic proposition to operate it ; it would be cheaper to buy a new machine. From a financial point of view, when that time comes, the business must be able to make the outlay without undue disturbance of its working capital.

As to whether or not the machine can be replaced without any financial strain depends upon the method of depreciation adopted. If the money is retained in the business that money is used as extra capital and may not be readily available when wanted. If, as in the sinking fund method, it is invested in securities outside the business, then these securities have only to be realised by sale and we are furnished with the money to pay for the new machinery.

Cost of machinery fluctuates from time to time ; those who have watched the markets from 1921 to 1941 will readily know what this means. It often means that a machine bought in 1931 will have to be replaced in 1941, but the calculations made on the 1931 price will be hopelessly out this year. But this error might be corrected by the fact that replacement might be postponed until 1942, because of the good values of the materials used, the good design of the machine, the care taken in using the machinery and the employment of skilled mechanics for all repair work.

Again, if no new model of that machine has made its appearance on the market so as to render obsolete the old model, the replacement of the old machine may likewise be postponed for a year or so. Thus does a depreciation fund become greater to meet the higher price of the new machine. When machines cost more, as in the present year, the scrap values of the old machines also rise, but not to such an extent as to make up the difference between the present price and the estimated price made ten years ago.

Salvage Values and the Market.—The residual values of machines are affected to a large extent by the fact that they may be applicable to one particular process or product. A glass moulding machine could only be disposed of to a firm requiring one of these machines. This is of more importance to a firm that wishes to dispose of a small model in order to purchase a larger one. In this case the market is " narrowed down " so that the price falls. On the other hand, a gas engine can be used in many industries, and so we may expect to get numerous buyers into the market.

Again, in the case of electric motors, &c., we have numerous makes, patterns, voltages, horse-powers, output speeds, &c., and unless you can find a buyer for the one you wish to dispose of—and this buyer may take some finding—you cannot sell it. The fact that you will have only a few offers will effectively prevent you from " holding out " for your price. If you have one buyer only, you will have to accept his price.

The residual value of a machine in five or seven years' time is therefore in the nature of a lottery, although you have calculated upon a definite value for it. Therefore give a low estimate so that you may not be disappointed. The scrap value of a piece of machinery—say, a boiler—may be £50, which may be the value of the metal in it. Then you have to dismantle it and this may cost £20. Again, machinery when bought has to be installed, and this labour is added to the cost and must be provided for in arriving at the sum for yearly depreciation.

The Straight-Line Method of Depreciation has the following advantages :—

(1) Ready method of application.

Although depreciation in the true sense is never equal, year after year, nevertheless for record purposes it is an advantage to make it so. It appears to give some stability to the records, and more particularly so when, at the end of the period, it is often found that the calculated depreciation is about equal to the actual wear and tear that has taken place.

(2) The equal yearly charges against profits are preferred by many business men, because they tend to give a clearer view of business activity.

It tends to eliminate a variable factor in the profits—one variable factor, at any rate—so that if profits do vary they vary for some other reason. It is one factor less to search for.

But it also has disadvantages as :—

(1) New calculations have to be made each time machinery is purchased, and in most instances a new set of machinery or a new machine may be purchased every year.

The ease with which the calculations can be made by the equal instalment method is an effective " set-off " against the extra work entailed.

(2) It takes no note of interest on the outlay.

Neither does the diminishing balance method, but the annuity and the sinking fund methods do consider the interest that the money might earn in or outside the business. For small units of machinery costing anything up to £500 this factor of " interest that the money might earn " is of little importance, taking into consideration the complexity of the calculations required. The matter is different if the outlay on some highly complex machine, or group of machines, is in the region of from £50,000 to £250,000.

A third disadvantage is the fact that as small renewals and repairs under this equal instalment system are charged to revenue, they are part of the usual overheads, and they tend to increase each year. In the sixth year they may be costing four times as much as they did in the first year. If, therefore, the cost of small renewals and repairs be added to the charge for the yearly depreciation, you have an increasing charge against the profits every year. This increase is often lost sight of under the guise of " Repairs and Renewals." This is why some industrialists prefer the diminishing balance method.

The Diminishing Balance Method

Many call this the reducing instalment system, because every year the depreciation (or the yearly charge against profits), becomes less and less. While it becomes less and less the repairs and small renewals to the machinery get more and more. By the combination of the two there is a chance of

achieving an equal charge against each year's profit.

If machinery is bought for £500 and an allowance is made for its scrap value at £50 at the end of seven years, then it might be thought advisable to depreciate this outlay of £450 by 20 per cent. per annum, and this seems to be excessive at first sight; but we shall find that at the end of the seventh year the book value of the machine is £94 7s. 5d. to the nearest penny, and not £50, as we expected it would be. But if the rate of depreciation is continued until the tenth year the book value is reduced to £48 6s. 4d. and one-third of a penny.

Reviewing the figures of our calculations—they are not shown here because we wish to save space—we find that the first year's charge is one-fifth of £450, which is £90. But the seventh year's charge is very much smaller, being only £23 11s. 10d. In the tenth year it has been reduced to £12 1s. 7d. as a depreciation charge against profits.

Advantages of this System.—Now it may be thought that the tenth year's provision of £12 1s. 7d. for depreciation—compared with that of the first year, £90—is rather absurd. But, when compared with actual depreciation, it is just the opposite. Again, it may appear absurdly small, but in this tenth year the cost of small renewals and repairs to that machine may have been about £100, while in the first year the cost for repairs may have been about £15, probably less. The advantage of this system may readily be inferred from the above figures and suppositions.

Another advantage is that there are no new calculations to be made when new machinery is bought. Simply add the cost of the new machinery on to the balance and deduct the same percentage, 20 per cent.

There is, of course, one disadvantage, namely, that to reduce the book value of a machine that cost £1000 to £100 in six years a high rate of depreciation must be taken. The percentage is usually much higher than most business men would agree to, because it acts as a handicap to profits in the first three years. Let us give figures in support of this.

Suppose it were suggested that this machine should be depreciated at the rate of 30 per cent. per annum, most industrialists would think this quite absurd, since the average rate of wear and tear allowance on most industrial machinery—as allowed by the Inland Revenue authorities—is from 5 per cent. to 7½ per cent. For certain complex machinery this may be raised to 10 per cent. or 12½ per cent., and even to 15 per cent. for certain machinery in the synthetic dye industry. But 30 per cent. depreciation—why, no engineer or cost accountant would ever be able to persuade the higher officials or directors that such a high rate was necessary. In any case, there would be a lively discussion about it.

Yet what do we find? Let us see.

		£	End of
1936–Jan. ...	Cost of machine	1000	
Dec. ...	Depreciation 30 per cent.	300	
1937–Jan. ...	Balance	700	... 1st year
Dec. ...	Depreciation 30 per cent.	210	
1938–Jan. ...	Balance	490	... 2nd year
Dec. ...	Depreciation 30 per cent.	147	
1939–Jan. ...	Balance	343	... 3rd year
Dec. ...	Depreciation 30 per cent.	102·9	
1940–Jan. ...	Balance	240·1	... 4th year
Dec. ...	Depreciation 30 per cent.	72·03	
1941–Jan. ...	Balance	168·07	... 5th year
Dec. ...	Depreciation 30 per cent.	50·421	
1942–Jan. ...	Balance	117·649	... 6th year

Here we see that when the rate is as high as 30 per cent. the book value of the machine is £117 12s. 11¾d. But we proposed to write it down to £100 in these six years. Now the total depreciation provided for in these six years is £882 7s. 0¼d. —and £657, or 74·46 per cent. approximately of it has been provided in the first three years. To the directors of most companies this seems to be too heavy a load on the profits of the first three years, and they may reasonably be excused from adopting this high rate of depreciation for the reasons given. But there are exceptions.

Making and Marketing New Commodities.—A complex piece of machinery may become "obsolete" in four or five years owng to the appearance on the market of a new machine with greater productive capacity or by the discovery of a new process of manufacture. Industrialists may therefore be persuaded to adopt the diminishing balance method of depreciation to "write off" 86 per cent. of the outlay on the machinery in the first four years.

When a new commodity is to be made for the market it means a large initial outlay for machinery, say, for the making of a calculating machine or a vacuum cleaner introduced in the past ten years. Owing to the high cost of introducing and selling these lines to the public the price is naturally high. Financiers wish to conserve as much of their capital as possible, because they know that once they have "got the thing going" others will soon be in the same line, taking advantage of their pioneering work.

Competition will lower prices in the third or fourth year, and the company will feel happier about the prospects if, by that time, something like £760 has been provided out of every £1000 of the initial expenditure for the purchase of new machinery, if only for the reasons given in the following paragraphs.

The person who puts a new commodity or machine on the market and opens the market for it does not always introduce the best model. A competitor may evolve something much better after he has seen the first model working for a matter of eighteen months or so. This often happens and the peace of mind of the man who has done all the pioneering work is naturally greatly disturbed.

The fact is that he may reasonably expect it, because no person can see everything clearly in the future. He, the pioneer, may see faults in his own production after it has been on the market over a year. He may make attempts to remedy these, but to make an entirely new model to "hold his own" in the market among competitors in the third year may mean heavy expenditure of capital for entirely new machinery and plant and a new lay-out of the factory. The most that could be expected would be a new model of the machine in the fourth year, a model which would conserve any advantages of the old machine and would give the public the benefit of new discoveries in connection therewith. Again, to meet the keen competition there might be a reduction in the price, brought about by the smaller selling expenses.

In such cases this diminishing balance method might reasonably be adopted and worked out by a formula, sometimes given as :—

$$(1-r)^n = \frac{\text{Scrap value}}{\text{Cost}}, \text{ or } \text{B R} = \sqrt[n]{\frac{\text{Scrap value}}{\text{Cost}}}$$

B R is the balance ratio, and, in the example given above, we may say that at a constant percentage depreciation of 30 per cent. the balance ratio is seven-tenths of the previous balance throughout the period. If you find this balance ratio you can readily find the depreciation rate necessary to reduce the value of the asset to any scrap or residual value you wish in a fixed number of years, since you know at the start the values of n, the cost and residual value; n is the fixed number of years—in our example, six.

(To be continued)

Determining the Case Depth of Carburised Work*

THE determination of case depth is one of the commonest operations in the heat-treatment shop and the controlling laboratory. Whether the depth of case is determined by means of a fractured test piece or by breaking one of the components which has been carburised it is not always an easy matter to distinguish the line of demarcation between the case and the core. It is especially difficult to measure the case depth of high alloy steels, owing to the extremely well-refined structure of the steel, which shows little difference between the grain size of the case and the core. It is also difficult to distinguish between the case and the core of plain carbon steel test pieces if they have been quenched off in a hurry without the proper core-refining treatment.

The usual method of case depth determination by grinding the carburised section and etching it with nitric acid in a solution of alcohol is well known, but it requires chemicals and equipment which are not readily available in a heat-treatment shop. The following method of dealing with carburised test pieces or fractured components is quite simple and requires very little equipment.

The fractured carburised test piece or component is heated and quenched in the ordinary way and broken to reveal the fracture. The broken part is then gently heated in a flame from a gas torch or Bunsen burner, care being taken to concentrate the heat some distance away from the fracture. The article should be removed from the flame from time to time and the fracture should be examined for any colour change. As soon as the first positive change in colour becomes visible, the heating should be stopped and the part should be quenched immediately in water. With a little practice, it will be a simple matter to stop the heating at the right stage. After the moisture has been evaporated, the case and the core will be seen to stand out in colourful contrast. The evaporation of the water will be accelerated by removing the quenched part out of the water while it is still warm. The best results are obtained when the core reaches a bright brick-red colour; at this stage the case will stand out clearly as a blue ring surrounding the core.

The process is not difficult to carry out, and very creditable results may be obtained even at the first trial. The equipment required is of the very simplest kind, and is to be found invariably in every heat-treatment shop. The results obtained are so distinct and pleasing that the few extra minutes required will be well repaid by the certainty with which the case depth is determined. The adoption of this method will also result in the elimination of eye strain which is inevitable when one is trying to estimate the depth of case where the case and the core are of the same colour.

* From the *Wild-Barfield Heat-treatment Journal.*

Portable Concrete Mixer

THE accompanying engraving illustrates a portable concrete mixer supplied by Blaw-Knox, Ltd., of Euston Road, London, N.W.1, in two sizes, with net batch capacities of 5 and 7 cubic feet capacity respectively. Each unit is designed to be drawn at high speed behind a lorry, and for that purpose is carried on a sprung frame and pneumatic tyres. The towing pole is telescopic, so that it can be pushed back out of the way when the mixer is in use. A retractable front leg can be swung up out of the way when towing, and in the back of the machine there are two further retractable legs which swing down and take the weight off the springs and tyres when mixing is in progress. The power unit is a single-cylinder air-cooled petrol engine developing about 7 H.P., and

PORTABLE CONCRETE MIXER

running at 1800 r.p.m., and the speed is reduced 4 : 1 by a Triplex chain gear enclosed in an oil bath. From the engine unit power is transmitted by duplex roller chain to a countershaft running in self-aligning ball bearings, and thence by heavy bushed roller chain to the drum. A clutch enables the engine to be started without driving the drum. The drum is constructed of high carbon wear-resisting steel, electrically welded to pressed steel drum ends. The charging and discharging openings are 19⅛in. and 17in. dia. for the smaller unit and 20¼in. and 17in. dia. for the larger. The drum runs at 20 and 18 r.p.m. in the smaller and larger units respectively. Buckets, five for the smaller, six for the larger, are equally spaced around the internal periphery of the drum, and five blades are placed on the charging side to feed the material into the cascading buckets. The power loader is hoisted by wire ropes from an overhead winding shaft and the clutch has an automatic knock-out, so that when the loading bucket reaches its highest position the brake is automatically applied. Discharge along the wide discharge chute can be effected in 7 sec. A water tank of 11 gallons capacity is fitted, with an air release valve and sight glass. The exact amount of water is measured by setting a siphon to a level determined by scale and pointer. The following table gives some further particulars :—

Type	58	78
Nominal capacity per batch—		
Dry, cubic feet	7	10
Wet, cubic feet	5	7
Overload capacity, per cent. ...	10	10
R.p.m. mixing drum	20	18
Weight	1 ton 4 cwt. 3 qr.	1 ton 8 cwt. 2 qr.

The Engineer

AUGUST 8, 1941

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NOTICES TO READERS

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CHANGES OF ADDRESS

*** *Will Subscribers please note that in all advices regarding changes of address it is necessary to have* **both the old and new address,** *as our lists are kept alphabetically by towns. Advices of this nature should reach us by the first post Wednesday morning prior to the alteration.*

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SEVENTY-FIVE PER CENT.

IT was evident from the tone of the Prime Minister's speech on Production in the House of Commons on July 29th that he was greatly disturbed by the effect overseas of the debate on the same subject when the House was in Committee of Supply on July 9th and 10th. He was especially perturbed by the assertion of Sir J. Wardlaw-Milne that "our people are only working up to 75 per cent. of their possible efficiency." For his uneasiness he had good grounds. The debate itself, and much that preceded it in the papers and elsewhere, has created a bad impression abroad, an impression that British industries are riddled by inefficiency and mismanagement. Mr. Churchill took great pains to show that such a general charge is unjustified, and that a constant drive towards improvement and the removal of defects, goes on. Observing that it was difficult to find a definite basis for Sir J. Wardlaw-Milne's estimate, he selected the three months immediately following Dunkirk, and showed that it would be unfair to industry to take the effort at that time as a datum. Such an effort could not be maintained indefinitely, and to attempt to maintain it would inevitably lead to a falling-off in output. The fact is that the production machine was working on over-load during that period. What is the normal load? That is extremely difficult to say, and any round figure such as 75 per cent. can be no more than a more or less intelligent guess.

But assuming for a moment that the country is capable of increasing its output by 25 per cent., is the position one to be ashamed of? We think not. On the contrary, we are inclined to take the opposite view and to say that any country which, in the course of two years whilst involved in a war on many fronts and subject to enemy attack, had created a machine which reached 75 per cent. of its possible output had done very well indeed. Mr. Churchill, in a striking passage of his speech, showed the obstacles with which we had to contend. First, there was the need of relaxation amongst workpeople, then there was the change in the diet of the heavy manual worker, thirdly, the employment of trainees and newcomers, and, lastly, the dislocation by reason of air raids which had to be met by "dispersion." All those things have interfered with the smooth running of production. Yet, said Mr. Churchill, "despite dilution, dispersion, reduced food, the black-out, and all the troubles I have described, each man is turning out, on the whole, each day, as much as he did in that time of almost superhuman effort" just after Dunkirk. "All the adverse factors I have described," he continued, "have somehow or other been cancelled out by superior development of our machinery and organisation." That was not, he said, cheap and facile optimism, but "if, for days on end, the whole national effort is disparaged and insulted, and if, all over the world, we are depicted by our friends and countrymen as slack, rotten, and incompetent, we are entitled, nay, it becomes a pressing duty, to restore the balance by presenting the truth." That everything was running with complete smoothness he did not claim, but he expressed his confidence that the defects were recognised and known, and were being grappled with and overcome. He dealt, as recorded in our "Journal" last week, with the machine tool question; showed that in the twenty-three months of the war less than 2,000,000 days have been lost by trade disputes; claimed that the priority question had been practically solved; touched upon the influence of aeroplane design upon output; and reported that in the last three months twice as many field guns had been made as in the Dunkirk period, and 50 per cent. more ammunition. With regard to aeroplanes, he asked the Committee to be content with his assurance "that progress and expansion on a great scale are continuous, and are remorselessly spurred on."

The counsel for the prosecution always seems to have an overwhelming case—until the defence is heard. In the two days' debate of July 9th and 10th, critic after critic arose and exposed this fault and that. Those criticisms were widely circulated, and we have little doubt that they gave a wrong impression in some parts of the world. Where free speech is allowed, that is inevitable. People listen to the criticism which is often snappy, but are deaf to the defence, which by its nature is often stodgy. They condemn the prisoner out of hand. Mr. Churchill's fear that that may have happened in this instance was no doubt well grounded, and because of its injustice to our war effort he spoke with no little warmth. To some of the criticisms he replied in detail, but with regard to others he was evidently embarrassed by the fact that secrecy had to be observed in the national interest. In those cases he appealed to the critics to bring instances of defects that had come to their notice before the appropriate Departments. That was better than ventilating them in the House or in the Press. That is obviously the right, and we hope the usual, course. The Member of Parliament has exceptional privileges, and he should be careful how he makes use of them. To begin with, he should make doubly sure of his facts. Then he should endeavour to find out if and what action has been taken with regard to them. Only then if he is still not satisfied is it his duty to bring them openly before the House. That procedure would appear to be particularly desirable when a country is at war, and when self-criticism may be used to its disadvantage by the propagandists of the enemy. No one doubts that faults still exist in our war organisation. Some of them, as "An Industrialist" showed in our pages a few weeks ago, are the affair of employers and employed themselves, and can be best resolved by open discussion and attention. Others are the direct and immediate affair of Government Departments. The Government is not blind to these defects, and, as Mr. Churchill was at much pains to explain, they have been or are being dealt with and removed step by step. It seems to be necessary to make this distinction. Industries themselves, employers and employed, can still do much to remove certain defects by voluntary effort, and without the coercion of the Government. The very interesting question of the employment of more women—ably discussed in a letter in our issue of August 1st—is a case in point. Whilst it is true that the Government is now in control of by far the greater part of the industries of the country, it yet remains possible to all those in the industries themselves to effect further improvements, and if we are to approach as closely as possible to the maximum output, it is essential that the industries—employers and employed—should settle for themselves those questions that come within their proper scope. We are well aware of the defects and disadvantages of Government control, and know full well what a discouraging effect it may have. Yet it would be deplorable if the Government were held responsible for everything, and industries refused to accept their fair share, small though it be, of the burden.

Taking Advantage of Low Temperatures

CARNOT'S theorem, as everybody knows, is the beginning of thermo-dynamical wisdom. It is true that, several years ago, Professor J. S. Haldane, with all the authority of an F.R.S., wrote books to demonstrate its falsity, but the theorem was less shaken thereby than the reputation of the professor. He might have equally well quarrelled with the Equator. But, like all concise statements of fact, the famous theorem is likely to be misleading, unless properly understood. As Captain Cuttle might have said, The moral of Carnot's observation lies in the application of it. One of the morals that can be drawn from it is that any reduction of the temperature at which a heat engine exhausts will bring about an increase in the efficiency of the engine.

Naïve inventors have therefore proposed the incorporation of some kind of refrigerating device in the heat cycle, so as to cause the engine to exhaust at a temperature lower than that provided gratuitously by Nature. But such a complication is needless. It would be quite sufficient to cause the expansion of the working fluid to be carried to a point at which the fluid would automatically become colder than the local air or cooling water, which is, indeed, usually the case with a compressed air motor. Not so very long ago a leading Continental firm of turbine builders publicly announced that it could thereby construct a gas turbine with an efficiency of over 100 per cent. The result of such a process would be, of course, to cause a negative loop in the temperature-entropy diagram, with disadvantages to the heat cycle similar to those caused to a work-cycle by a corresponding loop in an ordinary indicator diagram. Nature, so far as we know, has decreed that all physical transactions shall be carried out strictly in accordance with the second Law of Thermo-dynamics, and she cannot be tricked into permitting any action contrary to the law, no matter how ingenious the argument may be. It is no good to come before the court with the specious plea that, although super-cooled exhaust gases must ultimately return to atmospheric temperature, this will take place outside the engine, and therefore does not concern it. If water has eventually to be discharged into the sea, it will not generate any more power by making it work a turbine placed at the bottom of a coal pit. Kelvin put the matter in a nutshell when he told an earlier generation that nothing could ever be gained by allowing the working fluid of a heat engine to become colder than the cooling medium. This applies, of course, to machines for producing power. If the object is to produce cold, as in a refrigerating cycle, the converse proposition holds.

An obvious method of operating a refrigerating machine would be to compress air isothermally, and then to allow it to expand adiabatically behind a piston, when its temperature would be lowered in proportion to the work done. As an alternative, one can take advantage of the Joule-Thomson cooling effect produced when gas expands freely through a small orifice. This principle, as developed by Linde, has been generally favoured for such work as the liquefaction of air, largely because it avoids the difficulty of lubricating a piston at extremely low temperatures. But Professor Kapitza, who used to be in the Cavendish Laboratory at Cambridge, has now constructed an air-liquefying apparatus at the U.S.S.R. Academy of Science at Moscow in which a turbine exhausting at the extremely low temperature of —187 deg. Cent. is employed to absorb the work of the expanding air. It is only a small machine, developing about 4 kW at 40,000 r.p.m., but its working conditions are certainly unique in the history of turbine machinery. By its means, air can be liquefied with an initial compression of only about 5 atmospheres, whereas 200 atmospheres would be required for the Linde process. The apparatus employed by Professor Kapitza is briefly described by Mr. J. H. Awbery in an article in *Nature* of July 5th last. Although involving no novel scientific principles, it certainly marks a notable departure from current practice, and may open up for the turbine designer a new field at the low-temperature end of the thermometer scale.

Letters to the Editor

(We do not hold ourselves responsible for the opinions of our correspondents.)

A COUNCIL OF ENGINEERS

Sir,—The recent proposal by the President of the Institution of Electrical Engineers and your Leader in The Engineer of May 9th having the above title, in the latter of which you suggest that the "Engineers Advisory Committee" recently formed by the Government might, if properly handled, lead eventually to a "Council of Engineers," are happy auguries for the future establishment of an adequate engineering outlook, playing its proper part in the affairs of the country.

All which is so evidently desirable in the view of engineers that this writer would not waste space in commenting thereon, but that he may add an illuminating example of the actual functioning of engineering influence upon the major national affairs of another country, feeling sure that, now that the man-in-the-street — including engineers — at home is believed to be more receptive of practices current in some other countries than was the case some time back, the example will of be interest.

In the Republic of Colombia there is one central Engineering Society, the Sociedad Colombiana de Ingenieros, whose members are elected with customary safeguards as to their professional competence, and whose funds and establishment are (or were when the writer was in that country) aided by the Government, &c., and whose influence was such that not only was it customary for different Government Departments to refer knotty—and especially controversial—problems to it, but fairly frequently parliamentary measures adopted by the legislature carried a clause directing the Government to consult the Sociedad Colombiana de Ingenieros regarding their engineering aspects; even occasionally with the additional proviso that the fiat of such Institution, after a fully debated consideration of the matter in a duly constituted meeting, open to the Press, was to govern the final decision.

It should be noticed that this practice was in force in a country in a condition of particularly quick development, and hence the after-the-war period in England may be considered similar. The writer therefore brings this aspect of the matter into public light so that home engineers may visualise some further ways and means by which engineering initiative and safeguards may be used for the benefit of the country.

P. C. Dewhurst.

Montevideo, June, 1941.

INSTITUTION LIBRARIES

Sir,—The charming leading article, entitled "Of Institution Libraries," in your issue of July 25th is very encouraging to the band of technical librarians who, with very small staffs, endeavour to keep up to date and to render the professions the utmost service possible.

There are just two sentences in your Leader which might perhaps be amplified. First, "For the thousands of members living at a distance there is some excuse for indifference." On this point it may be stated that in the Institution of Mechanical Engineers' library, one-third of the books lent and of the inquiries answered go through the post, so that residence out of London does not debar members from using the library service.

The second comment is on the statement: "For every member upstairs in the library of any institution, you may find a dozen downstairs in the reading room busy with the current technical papers." On this, I would merely quote figures analysed during an August Bank Holiday week-end of fire-watching. For good and sufficient reasons, it was necessary during last year to institute a visitors' book, in which all callers at the Institution have to sign and state the purpose of their call. Out of 8498 callers so far, 5055 gave as the purpose of their call "Library" or "Reading Room," and of these, 3199 stated "Library" and 1856 stated "Reading Room." The impression you had gained, however, is probably commonly shared, and is no doubt contributed to by the fact that a reading room can only be used while one remains in it, but a library can be visited for a few minutes, and used for the next fortnight by virtue of the books taken home; indeed, it may be used through the post without visiting it at all. Librarians have endeavoured to improve their information service out of all recognition compared with days gone by. What we cannot do, however, is to write such an article as yours. The dryness of this letter compared with the language of your Leader is as chalk to cheese.

Alfred R. Stock, F.L.A.

London, S.W.1, August 5th.

Fenchurch Street Station Centenary

Saturday, August 2nd, marked the centenary of Fenchurch Street Station, the oldest London railway terminus. It was on August 2nd, 1841, that trains first began to run between Fenchurch Street and Blackwall on the London and Blackwall line. That railway began in July, 1840, as the Commercial Railway, and was built to carry passengers and goods from the City of London to the India Docks. It was built on arches, and a 5ft. gauge was adopted, with rope traction. The first terminus was in the Minories, but Parliament later granted permission to extend the line to Fenchurch Street. The reason for the adoption of rope traction was the fear that in a densely built-over district, with the line running level with the upper floors of the houses, red-hot cinders might be ejected from the chimneys of locomotives and cause fires in surrounding properties. Possible danger to health was also raised by the City Health Department, an objection which was rightly overruled. There were two lines from Fenchurch Street, up and down, and two trains which ran each over its own line. The trains were non-stop from both termini and several other stations which the lines served. Taking the journey from Blackwall to Fenchurch Street, the composite coaches were arranged with two in front for Fenchurch Street, followed with one each for Shadwell, Stepney, Limehouse, West India Docks, and Poplar. The rope was hauled by stationary engines, and the guards on each coach uncoupled their units and braked them, so that they drew up at the platform of the required station. The coaches were reassembled at the termini, and on the two lines a quarter-hourly service was run, one train starting from each terminus at the same time, on the north and south lines in turns. In view of extensions, the company obtained powers to reduce the 5ft. gauge to the standard gauge of 4ft. 8½in., and to abandon rope traction for locomotives. A branch of the railway from Stepney to an interchange station with the Eastern Counties Railway at Old Ford was opened at the beginning of April in 1849, by which time the whole of the system was worked by locomotives. We may recall that in 1935 the whole of Fenchurch Street Station was remodelled and completely modernised at a cost of about a quarter of a million pounds.

Sixty Years Ago

The Institution of Mechanical Engineers at Newcastle

In 1881 the Institution of Mechanical Engineers held its thirty-fourth annual Summer Meeting at Newcastle-on-Tyne, under the presidency of Mr. E. A. Cowper. The President, in his inaugural address, recalled the meeting in 1847 at which George Stephenson proposed the formation of the Institution, and said that he himself had had the honour of seconding the proposal that Stephenson should be the first President of the new institution. The meeting was marked by the presentation of a number of good papers and by discussions thereon of a generally poor, and at times regrettable, kind. Mr. Lothian Bell opened with a paper "On the Tyne, as Connected with the History of Engineering," on which there was no discussion of any kind. Mr. F. C. Marshall followed with an excellent paper "On the Progress and Development of the Marine Engine," which was accorded a discussion "quite unworthy of it," to quote our account of the meeting. A paper on "Printing Machinery," by Mr. Jameson, opened the second business session of the meeting, but the members found nothing in it to discuss, and, following a visit to the offices of the *Newcastle Chronicle*, they departed for Jarrow to take lunch at and to inspect Palmer's works. On the third day Mr. Cookson presented a paper, "On Some Recent Improvements in Lead Processes," which was very briefly discussed. Mr. Strong, of Philadelphia, next submitted a paper, "On a Feed-water Heater and Filter for Stationary Engines," which seems to have provoked a little more interest than any of the other papers. Mr. Price came next with a contribution, entitled "On Iron and Steel as Constructive Materials for Ships." The discussion on this paper was characterised by an acrimonious dispute between the author and Mr. Denny, the nature of which was such that we felt we would be consulting the interests of the Institution by not reporting it. A final paper, by Mr. Boyd, "On Slipways," failed to produce any discussion. Commenting in a leading article on the meeting as a whole, we said that the time had now come when a decision should be taken as to whether the Institution's annual Summer Meetings should be organised as occasions of pure pleasure or as opportunities for the profitable interchange of views. The debating ability of the members was falling off. There was, we said, no more lamentable sight than that presented by a President compelled to ask one man after another to get up and say something, unless it were that supplied by the man, who, taking pity on the President, got up to talk against time on a subject about which he knew next to nothing.

Literature

SHORT NOTICES

Civil Defence. By C. W. Glover. Third edition, completely revised and enlarged. London, 1941: Chapman and Hall, Ltd. Price 42s.—This book first appeared in July, 1938, when war was in the air, but everyone was hoping that it might be averted. Little more than a year later, two months after war had been declared, a second edition was issued. Bombing of cities had not yet begun, but everyone knew that it would probably come, and hurried provisions for meeting it were being made. A few months later France succumbed, the Germans got airfields close to our shores, whilst their own cities were far distant, and persistent bombing of London and other cities began. Mr. Glover's volume was the text-book of those who had to consider defensive measures. Now, after a year of aerial attacks, a new edition, revised and enlarged, has appeared. The author claims "that the acid test of actual war conditions has only served to confirm the soundness of the principles of the science outlined in the earlier editions." Too little is publicly known about the effects of bombing to say whether or not that claim is fully justified. But it is known unhappily that several "shelters" which were believed to be proof against attack have failed disastrously. That was, perhaps, because bombs greater in weight and more powerfully charged came into use as the war progressed. Mr. Glover repeats his original tables and diagrams of bombs, but it is conceivable that they call for considerable revision. If there are similar tables and diagrams in Germany they must all have been cancelled when we started, a few months ago, to use a new bomb with five times the explosive energy of the old. The author deals as fully as circumstances will permit with the demolition and blast effect of bombs, but as far as we can see he does not pay much attention to what has been aptly called the "trigger" effect; for example, a tower or lofty building falling upon and destroying others. When the whole subject can be examined it may be that that will be amongst the most important items to consider if bomb-proof cities have to be built. We trust very deeply that we may never have to record it, but the bombing of a city of skyscrapers would be profoundly instructive.

The value of Mr. Glover's book is its comprehensiveness. It goes into every aspect of civil defence against aerial attack, even including personal protection against gas and the duties of the A.R.P., fire watching, camouflage, &c. The drawings and diagrams in it are excellently clear. It is a very fat book, printed on good paper in large type. As a compendium of the subject we have nothing but praise for it.

A Desert Railway.—Proposals are afoot to construct a railway across the Sahara Desert in order to link North Africa with Dakar. The route intended will be approximately 2000 miles long.

Oxygen-Boosting of Diesel Engines for Take-Off*

By P. H. SCHWEITZER and E. R. KLINGE

Introduction

Aeroplanes require roughly one-third more power during the take-off than in flight. The take-off period takes one to three minutes. The power output of an engine depends on the amount of fuel it can burn per minute. The maximum amount of fuel burnt is roughly proportional to the amount of oxygen available for combustion. By feeding oxygen into the intake air of the engine its power output was expected to increase.

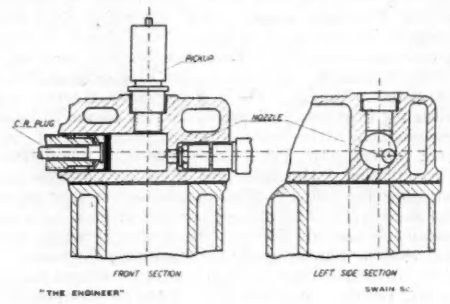


Fig. 1—*Cylinder Head*

The investigation of oxygen boosting of a diesel engine was undertaken in the hope that the increase in power output would not be accompanied with excessive pressures or shocks. The principal question to be cleared was not whether the engine would respond to the oxygen feed, but whether it would be able to stand it.

Apparatus

All of the test work was done with a one-cylinder, 3½in. by 4½in., four-stroke, C.F.R. diesel engine unit, as manufactured by the Waukesha Motor Company in 1934. The engine is V-belt connected to a three-phase induction motor with synchronous characteristics, such that the engine speed is regulated to 890±2 r.p.m. under all loading or motoring conditions. It is of the pre-combustion chamber type, as shown in Fig. 1, and has an adjustable plug for varying the compression ratio. The variable compression feature was used in the starting assistance work of this investigation. For the power boost work of the investigation it was permanently set for a compression ratio of 15·8 : 1. The injection system components are a Bosch pintle nozzle, set to 1400 lb. per square inch opening pressure, a 25in. by 0·125in. i.d. injection line, and a Bosch injection pump, with a 5 mm. diameter plunger set so that the port closes for the start of delivery when the plunger has lifted 0·140in. from the cam base circle. This engine was chosen for the work (1) because of its small displacement and consequent small oxygen requirements; (2) because of its complete and automatic speed regulation; (3) because of its extremely heavy construction to withstand unusual stresses; and (4) because of the ease with which much accessory test equipment could be mounted and used.

The oxygen was fed to the intake from a standard 220 cubic foot tank, through a pressure regulator, a calibrated flow orifice for making quick flow adjustments, and a gas meter for measuring total flow. The oxygen was mixed with the intake air at the base of a 7 cubic foot surge tank, and continued through a heater section and 3ft. of intake pipe of varying cross section. The set-up is shown schematically in Fig. 2.

The power output of the engine was determined by measuring the output of the synchronous generator into the three-phase, A.C., 220-volt line. Two kilowatt meters for simultaneous reading were arranged for this purpose, Fig. 2. These readings were calibrated against the readings of a prony brake which measured the C.F.R. engine output directly (generator disconnected).

Smoke measurements were made with the Penn State smoke meter, as shown in Fig. 3. The smoke meter is a tube with a light and shutter at one end and a light intensity meter at the other end. The tube is 18in. long and is sealed with a window at each end. The light intensity is adjusted with the shutter to some standard value while the tube is being scavenged with air. The per cent. reduction in light intensity while the tube is filled with engine exhaust is the smoke density. When the Penn State smoke meter registers 50 per cent. smoke density, the exhaust just begins to become visible to the naked eye against a blue sky background.

The angular positions of the beginning of the fuel injection and the start of combustion were determined with the Aminco-Penn State ignition lag indicator. Electro-magnetic pick-up units are mounted one at the end of the injection nozzle feeler pin and one in the combustion chamber. Figs. 4 and 5 are drawings of the pick-ups. Impulses from these pick-ups trip thyratron relay circuits which light neon lamps mounted in a protractor on the engine fly-wheel. The angular positions of the neon flashes, while the engine is running, locate the two events desired. The angular difference between the injection flash and the ignition flash is the ignition lag in degrees crank angle. The wiring of the ignition lag indicator is shown in Fig. 6.

The output voltage of the same electro-magnetic combustion pick-up that was used for ignition time determinations was used for measurement of maximum cylinder pressures and maximum rates of pressure rise. This pick-up impulse is amplified and indicated with the Penn State-RCA cathode ray oscillograph engine indicating unit, as shown in Figs. 2 and 4. The pick-up voltage is proportional to the rate of pressure change in the engine. The "direct" diagram on the 9in. oscillograph screen can be used for M.R.P.R. (maximum rate of pressure rise) determinations. The M.R.P.R. of compression was determined from a pressure-time diagram of compression. With the M.R.P.R. of compression known for the compression ratio being used, and the relative heights of the M.R.P.R. of compression and combustion scaled off the oscillograph screen, the M.R.P.R. of combustion is determined. Figs. 7 and 9 are photographs of rate of pressure rise *versus* time diagrams.

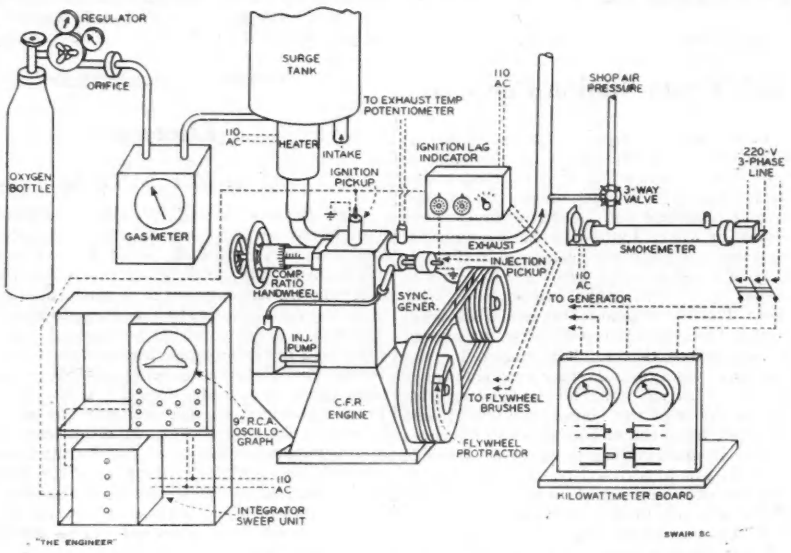


Fig. 2—*Arrangement of Test Plant*

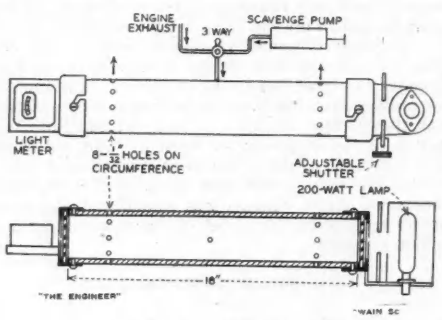


Fig. 3—*Penn State Smoke Meter*

The first integral of the pick-up voltage is proportional to the cylinder pressure because the pick-up voltage is directly proportional to the rate of pressure change. This integration is accomplished electrically in a unit designed for the purpose. When using the integration circuit the diagram on the screen is a pressure *versus* time diagram. Figs. 8 and 10 are photographs of pressure *versus* time diagrams. For calibration the maximum pressure of compression was determined for all compression ratios and compared with the maximum pressure of combustion to find maximum cylinder pressures in the same way that the M.R.P.R. was measured. The maximum pressure calibration was done with a differential pressure diaphragm calibrating unit, as described. It is a very small movable disc, exposed to cylinder pressure on one side, and a balancing pressure from an air bottle on the other side. The disc moves up when the cylinder pressure exceeds the balancing pressure and remains up until the cylinder pressure drops below the balancing pressure later in the cycle. It then drops down. Each motion of the disc is picked up by an electro-magnetic pick-up and recorded on the oscillograph screen as a small "kick." The location of these "kicks" (by means of a degree crank angle scale thrown on the screen) at a number of balancing

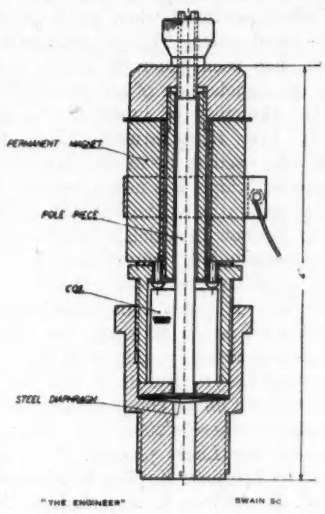


Fig. 4—*Combustion Chamber Pick-Up Unit*

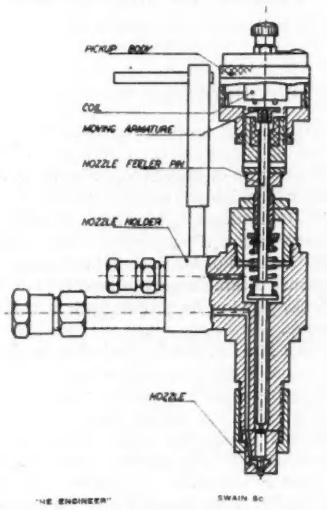


Fig. 5—*Injection Nozzle and Electro-Magnetic Pick-Up*

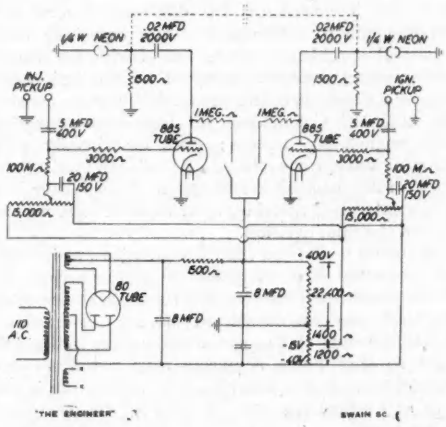


Fig. 6—*Wiring Diagram of Penn State Ignition Lag Indicator*

* The Pennsylvania State College Bulletin

pressures outlines a very accurate pressure *versus* time diagram. Fig. 11 shows a schematic arrangement of the pressure calibration equipment.

Exhaust temperatures were measured with a chromel-alumel thermo-couple mounted in a well, open to the exhaust gas, but shielded from exhaust pipe radiation. This couple and well are fixed in the exhaust pipe about 3in. away from the engine exhaust valve.

The fuel used in the main investigation was a light diesel fuel with the following specifications :—

Cetane number	55·9
Kinematic viscosity, 100 deg. Fah.	3·24
S.S.U. (seconds), 100 deg. Fah.	37·0
Initial boiling point, deg. Fah.	422
10 per cent. recovered, deg. Fah.	478
50 per cent. recovered, deg. Fah.	527
90 per cent. recovered, deg. Fah.	585
End point, deg. Fah.	630
A.P.I. gravity	37·6
Flash, P.M., deg. Fah.	205
Pour, deg. Fah.	0
Sulphur	0·13
Corrosion at 130 deg. Fah.	Negative
Water and sediment, per cent.	None
Carbon residue, per cent.	0·014
Ash	None

PRELIMINARY INVESTIGATION

Preliminary work was done to determine that no serious difficulties were to be met in the course of the

FIG. 7

oxygen feeding experiments. Maximum pressures and M.R.P.R. were found to be reasonable and the ignition lag considerably shortened with oxygen additions. All power tests were run at a compression ratio of 15·8 : 1.

To determine the maximum possible power boost it was necessary to run the engine at optimum power conditions. At each intake charge oxygen concentration to be used for a power output trial, it was necessary to know the timing conditions for optimum

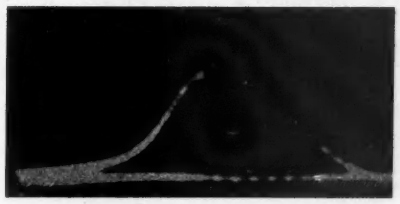


FIG. 8

power output. For example, Fig. 12 shows the results of the timing test made at 45 per cent. intake charge oxygen concentration. The curves show that the optimum power output occurred with 11 deg. injection advance with the resulting 6·5 deg. ignition advance. Similar tests were run at 21 per cent. (no oxygen addition), 28 per cent. and 33 per cent. intake charge oxygen concentrations. The results of all of these timing tests are the optimum timing curves of Fig. 14.

In comparing the power output at various oxygen

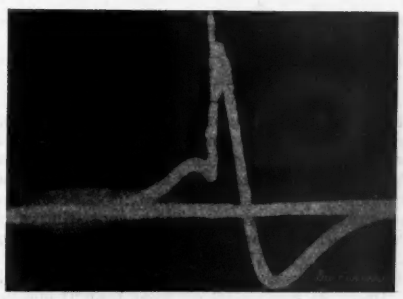


FIG. 9

concentrations a fuel rate should be used which corresponds to "full load" at that particular oxygen concentration and operating condition. Using the absolute maximum load the engine is able to carry is impractical, as under such load the engine soots up quickly. Instead, the comparison was based on "50 per cent. smoke" as measured by the Penn State smoke meter. This is the approximate limit of "clear exhaust." Fig. 13, which is a cross plot of Fig. 12, shows how the smoke density rises with increasing fuel rate, but is relatively unaffected by the injection timing.

The measured power outputs at optimum injection timing and 50 per cent. smoke would still be without practical significance if they were accompanied by combustion pressures exceeding the limits of safety or rates of pressure rise causing intolerable knock. Figs. 12 and 13 show how these factors vary with varying load and injection advance angle. A significant observation is that while the maximum pressure and maximum rate of pressure rise increase rapidly if the injection is advanced, they are relatively unaffected by the fuel rate (load). The ignition lag, which is believed to control to a great extent the

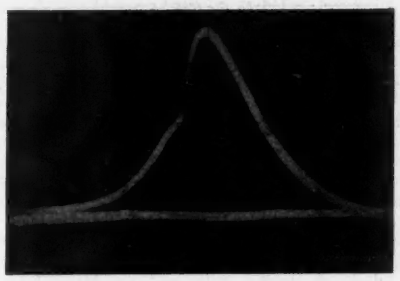


FIG. 10

maximum rate of pressure rise, appeared virtually unaffected by either the load or the injection advance.

TEST RESULTS ON POWER BOOST

Two series of tests were made to determine the gain in power output obtainable with oxygen boost. One of them was the test made at the fixed ignition time of 4 deg. advance, shown in Figs. 15 and 16. The other was the optimum timing conditions test shown in Fig. 17. The similarity of the results shows that the whole situation was not very sensitive to timing conditions, and that the results obtained are

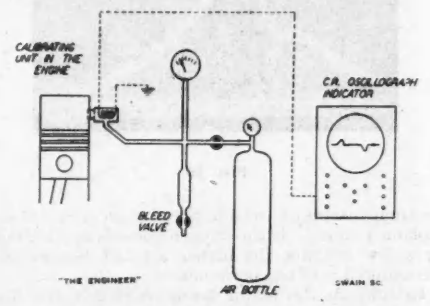


FIG. 11—*Schematic Arrangement of Pressure Calibration*

reasonably reproducible. The optimum timing conditions test only will be discussed, therefore.

Fig. 17 represents data for loads corresponding to 50 per cent. smoke density, which is considered as the full-load point on any running condition. To make sure that the results at exactly 50 per cent. smoke were recorded, fuel injection rates (in cubic millimetres per injection) were tried on each side of the rate supposed to produce 50 per cent. smoke. Thus, at each intake charge oxygen concentration a simultaneous smoke and power curve was determined, as well as curves for other data, M.R.P.R., maximum pressure, ignition lag.

The most important results of the oxygen boost

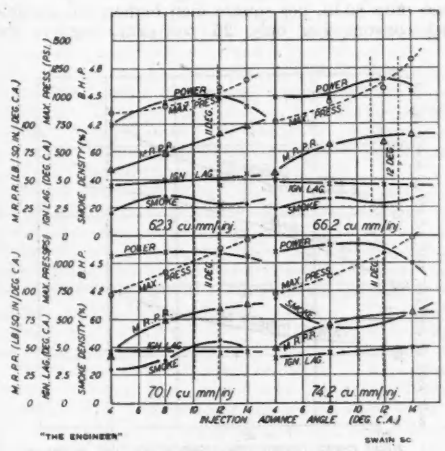


FIG. 12—*Effect of Injection Timing, Oxygen Concentration 45 Per Cent.*

are shown in Fig. 17. The brake horsepower increased from 2·9 to 4·65 H.P., an increase of 60 per cent., by increasing the oxygen concentration from the normal 21 per cent. to 45 per cent. It resulted from the ability of the engine to burn more fuel with the oxygen-enriched intake charge. The brake mean effective pressure was boosted from 70 lb. to 115 lb. per square inch, and the indicated mean effective pressure from 100 lb. to 150 lb. per square inch. The large difference between the brake and the indicated power is due to the low mechanical efficiency of the heavily constructed test engine.

Beyond 40 per cent. oxygen concentration the power increase is insignificant and at 55 per cent. it approaches zero. The specific fuel consumption increased at higher oxygen concentration.

It is, of course, natural that the thermal efficiency

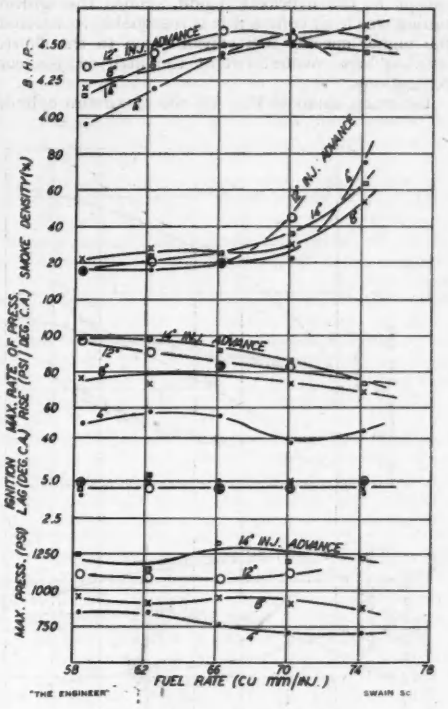


FIG. 13—*Cross Plot of Fig.* 12

of heat units added later in the cycle should be lower but in this particular engine two factors probably contributed to this effect. The first factor was that the standard injection pump was not large enough for boosted operation and the required amount of fuel was only delivered over a stretched-out injection

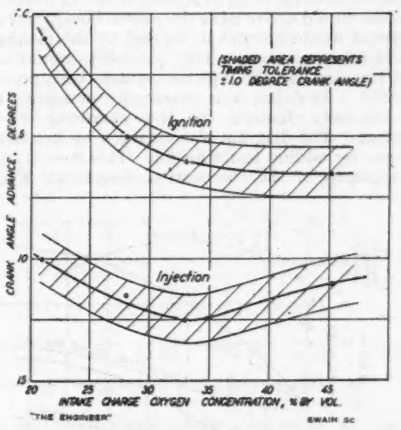


FIG. 14—*Timing for Optimum Power*

period of about 55 deg. crank angle. The other factor was that the extremely short ignition lag in boosted operation permitted insufficient time for good spray distribution. The 4 deg. ignition lag encountered at the highest oxygen concentration is only 0·75 milliseconds. In that time the tip penetra-

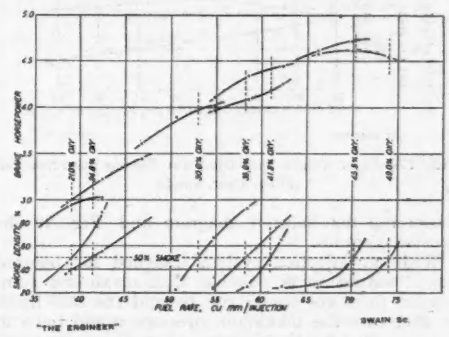


FIG. 15—*Tests with Four Degrees Ignition Advance*

tion of a cylindrical hole nozzle does not exceed 1½in. and the penetration of the pintle type nozzle is probably less. The turbulence in this particular combustion chamber was probably insufficient to compensate for the poor spray distribution. It has been suggested by Rothrock and Waldron that the

ignition lag can be too short for best efficiency. The short ignition lag may have been a factor in the poor fuel economy at high oxygen concentrations.

The latter hypothesis is supported by an examination of the fuel consumption curves plotted on a horsepower basis for various oxygen concentrations, as shown in Fig. 18. It is seen that at high oxygen concentration the specific fuel consumption is greater, except in the overload region. Since the ignition timing was kept constant it is reasonable to attribute the higher specific fuel consumption to the shorter ignition lags encountered at the high oxygen concentrations.

Referring again to Fig. 16, the maximum cylinder

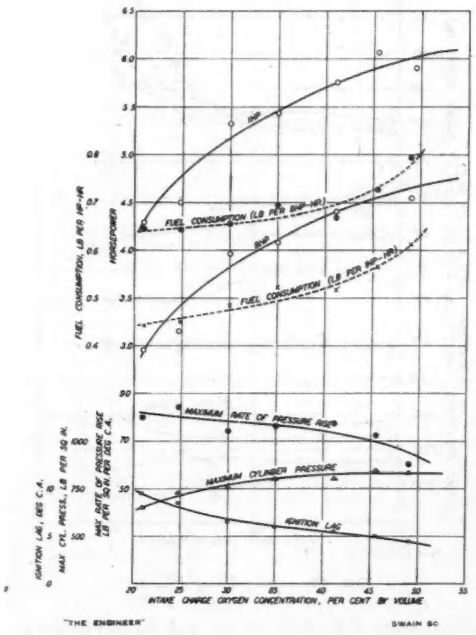


FIG. 16—*Final Results with Four Degrees Ignition Advance and 50 Per Cent. Smoke*

pressure increased but a small amount, 700 lb. to 780 lb. per square inch, with the added power output. It was expected that a much greater rise of maximum pressure would occur with the power boost, and that the boost would have to be limited by the maximum permissible pressures. This probably would have been the case had the injection system been properly adapted. Actually, the maximum pressures were automatically limited by the character of the injection. The diagram was enlarged by broadening but not by adding to its height. This is seen in the photographs of the combustion diagrams; Fig. 19

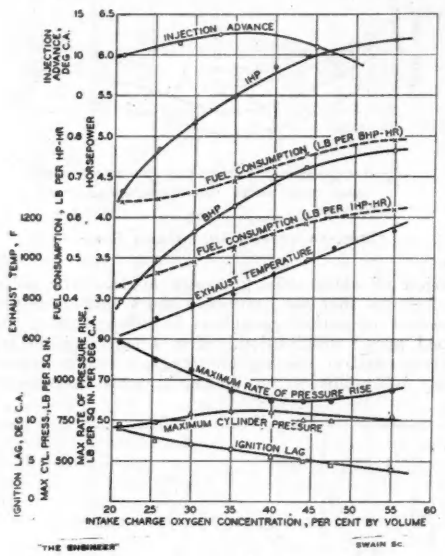


FIG. 17—*Final Results with Optimum Timing Condition and 50 Per Cent. Smoke*

shows the non-boosted diagram and Fig. 20 the boosted diagram.

With an injection system designed for boosted power output it is possible that maximum combustion pressures would rise beyond the safe limit. In that case the maximum pressure would have to be controlled by limiting the oxygen concentration or by retarding the injection, or both.

The maximum rate of pressure rise decreased with the boost in Fig. 17. The M.R.P.R. in this case was controlled by three factors. First, the action of the oxygen alone, everything else including the ignition lag being the same, increased the M.R.P.R. as shown in Fig. 21. Secondly, the earlier ignition time used with increased boost increased M.R.P.R. (Fig. 12). And thirdly, the greatly shortened ignition lag (Fig. 17) decreased M.R.P.R. The results indicate that the shortened ignition lag, with the resulting smaller accumulation of fuel in the combustion chamber before ignition, has been predominant. It was the saving factor against the badly increased

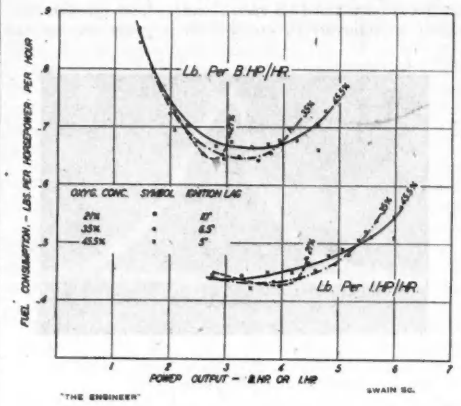


FIG. 18—*Fuel Consumption at Various Oxygen Concentrations of the Intake Air. Injection Timing such that Ignition Occurs 4 Deg. Before Top Centre*

M.R.P.R. (Fig. 21) due to the oxygen-accelerated combustion once ignition had started it.

Exhaust temperatures rose rapidly with increased boost (Fig. 17). This was to be expected on the basis of increased engine load. But this effect was probably

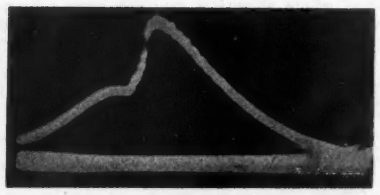


FIG. 19

over-emphasised by the late burning encountered and explained above. If the oxygen boost is applied only for a few minutes the higher exhaust temperature encountered is of no consequence.

To sum up the power boost results, it has been

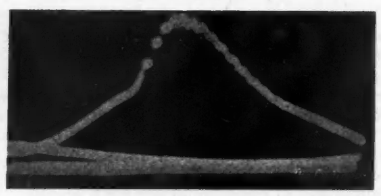


FIG. 20

shown that 60 per cent. power boost was accomplished with 160 per cent. increase in intake charge oxygen concentration, and the resulting maximum pressures were only 80 lb. per square inch higher, the specific fuel consumption only 25 per cent. higher, the

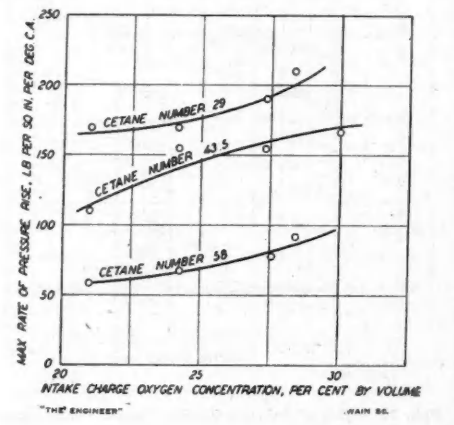

CETANE NUMBER 29
CETANE NUMBER 43.5
CETANE NUMBER 58
MAX RATE OF PRESSURE RISE, LB PER SQ IN. PER DEG C.A.
INTAKE CHARGE OXYGEN CONCENTRATION, PER CENT BY VOLUME
"THE ENGINEER"
SWAIN SC.

FIG. 21—*Maximum Rates of Pressure Rise at Constant Ignition Lag of 15 Deg.*

M.R.P.R. one-third lower, and the exhaust temperature remained within practical limits.

Practical Conclusions

Aeroplanes require about one-third more power during the take-off than in flight. In diesel-engined aeroplanes the size of the engine could be reduced by 25 per cent. by feeding oxygen into the intake air during the take-off. Applying the results of the experiments to a transport aeroplane, Fig. 22 shows the possible weight saving with various oxygen boosts. The curves are based on 6000 cruising horsepower and an estimated engine weight of 2 lb. per horsepower.

For the take-off 8000 H.P. are necessary. To supply the additional 2000 H.P., 200 lb. of oxygen are fed into the intake air during the take-off. The volume of 200 lb. of liquid oxygen is approximately 20 gallons. Standard liquid air containers of 55-litre capacity weigh 75 lb. Therefore the weight of the oxygen and container is 350 lb., while the possible saving in engine

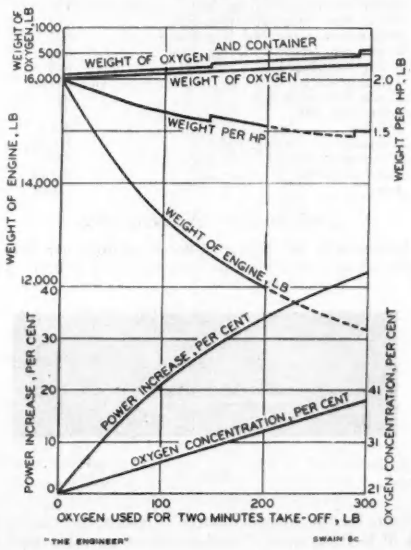


FIG. 22—*Effect of Oxygen Boost on Power and Weight (Cruising Horsepower 6000, Take-off Horsepower 8000)*

weight is 4000 lb. The weight per take-off horsepower is thereby reduced from 2 lb. to 1·54 lb. The calculation is shown in Table I.

Table I

Normal horsepower	6000
Take-off horsepower...	8000
Normal fuel consumption ...	0·4 lb. per H.P. hour, or 53·5 lb. per min.
Normal air consumption	900 lb. per min.
Normal oxygen consumption, 21 per cent. oxygen concentration	189 lb. per min.
Boosted oxygen consumption, 32 per cent. oxygen concentration	289 lb. per min.
Oxygen to be supplied	100 lb. per min.
Weight of 8000 H.P. engine ...	16,000 lb.
Weight of boosted 6000 H.P. engine	12,000 lb.
Weight of oxygen for 2-min. boost	200 lb.
Weight of container for 29 lb. of liquid oxygen...	150 lb.
Net weight saving by oxygen boost	3650 lb.
Weight per horsepower, non-boosted engine	2 lb.
Weight per horsepower, boosted engine	1·54 lb.

Oxygen addition may be used for starting diesel engines. The raising of the oxygen concentration from the normal 21 per cent. to 45 per cent. was found to be equivalent to a raise of approximately 10 cetane numbers as far as starting is concerned.

Five per cent. increase in oxygen concentration eliminated exhaust smoke completely.

The Bristol "Beaufighter"

The Bristol "Beaufighter" is a high-performance, all-metal, mid-wing monoplane, fitted with two Bristol "Hercules" engines. It is designed and equipped as a long-range day and night fighter, with exceptionally powerful armament, and accommodation is provided for a crew of two, consisting of pilot and observer. The principal dimensions are:—Span, 57ft. 10in.; length, 41ft. 4in.; height to the top of the rudder with the aeroplane in the rigging position, 15ft. 10in. It has an all-up weight of 21,000 lb., a nominal top speed of over 330 m.p.h. at 14,000ft., and a disposable load, including oil fuel, armament, &c., of 7200 lb., which is 34 per cent. of the all-up weight. It has a nominal range of 1500 miles. Its armament consists of four cannon guns in the fuselage and six machine guns in the wings.

The "Beaufighter" is of all-metal stressed-skin construction, with a monocoque fuselage. The main plane is a two-spar cantilever structure in three sections; the centre plane which passes through the fuselage is bolted to it and the port and starboard outer planes. The fin and tail plane are all-metal cantilever structures, and the control surface, rudder, elevator, and ailerons are metal structures with fabric covering.

Two Bristol "Hercules" III engines are installed in nacelles near the outer ends of the centre plane. They are of the air-cooled sleeve-valve radial type,

with fourteen cylinders in two rows, and are fitted with two-speed superchargers and constant speed airscrews. They have long chord cowlings, the exhaust collector forming the leading edge, and controllable gills are fitted round the trailing edge which govern the air flow for cooling purposes. Those engines develop 1400 H.P. for take-off; 1365–1425 B.H.P. at 1500ft., and 1220–1270 B.H.P. at 15,000ft. They have a diameter of 52in. overall and a cubic capacity of 38·7 litres. The fuel is carried in four self-sealing tanks, two in the centre plane and one in each of the outer planes. Separate oil tanks for each engine are mounted on the centre plane, and an oil cooler is mounted in each outer plane, the cooling air being collected by a duct in the leading edge of the wings. The capacity of the four fuel tanks is 550 gallons, weighing 3960 lb. The two oil tanks contain 18 gallons each. Electrical starters and hand turning gear are provided.

Two special hatches in the underside of the fuselage are provided for access to the interior. One between the centre plane spars for the pilot and the other for the observer further to the rear. These hatches swing down to open and entrance is effected by a ladder attached to them. Hand grips and hand rails are also provided. They are opened from the inside by means of a ver. These hatches are also intended for emergency exit by parachute. By a quick release, each door opens so that part of the door protrudes outwards into the air stream beneath the body. This creates a dead air region through which the crew can drop free without risk of injury, even in a dive up to 400 m.p.h. Additional emergency exits are provided, consisting of a knock-out panel on the starboard side of the pilot, a hinged window above the pilot, and a hinged hood above the observer. The pilot's seat with an indicator, mounted in a horizontal position near the base of the instrument panel.

The hydraulic system operates the undercarriage and tail wheel retracting gear and the split trailing edge flaps. Pressure is supplied to the actuating jacks by two power-driven pumps, one on each engine. The main relief valve for the hydraulic system is set at 1200 lb. per square inch. An emergency hydraulic system for lowering the alighting gear and flaps is provided and is operated by a hand pump, fitted under the pilot's seat and operated by a handle on the starboard side of the pilot's seat. For use in emergencies the handle is extended by pulling upwards on a twist grip and locking it in position. It is provided mainly for servicing purposes on the ground, but can also be used in flight, either to operate the hydraulic services if the engine pumps fail or the separate emergency system.

The controls for operating the hydraulic system are situated on the port side at the base of the instrument panel, and two gauges mounted on the port hand rail show the pressure delivered by the port and starboard pumps. Separate controls are provided for the undercarriages, and the flaps, both being fitted with indicators to show their positions. They are operated through a selector control lever, which should be in the "off" position, except when these services are being used. The undercarrige control consists of a lever which operates in the same sense as the movement of the units, namely, up to raise the units and down to lower them. The indicators for the undercarriage units are mounted on the port side of the instrument panel above the hydraulic control levers. When the three units are locked in the retracted position the indicators show the word "Up" on a red background, and when locked in the lowered

BRISTOL "BEAUFIGHTER"

is easily adjustable for height by means of a lever with a twist grip at the end, which locks it in position. A cabin heating system is fitted, controlled by a lever on the port side aft of the pilot. This operates a rotating louvre which admits hot air to the cockpit from the engine.

The alighting gear consists of three retractable units, hydraulically operated. Two independent undercarriages are fitted under the engine nacelles at the outer ends of the centre plane, into which they retract rearwards. The tail unit is also retractable forward into a recess in the fuselage. Electrical indicators and a buzzer in the pilot's cockpit indicate the position of the three units. Oleo pneumatic shock absorber legs are fitted, together with Dunlop pneumatically operated brakes. Automatic safety locks are provided on the undercarriages to prevent retraction when the aeroplane is on the ground. Hand-operated landing pins are also provided for attachment from the ground, and they are fitted with red flags which are visible to the pilot, and must be removed before flight.

The flying controls are normal and orthodox in operation. The ailerons and elevators are operated by a spectacle type hand wheel at the top of the usual control column through chains and cables. Gun-firing controls and a brake-operating lever are fitted on the spectacle hand wheel, the latter being fitted with a spring-loaded catch for applying the brakes for parking. The rudder is operated by pendulum type rudder pedals in parallel motion, the pedals being adjustable for leg reach. Locking gear for the flying controls is provided for parking the aircraft. Trimming tabs, controllable by the pilot, are set in the trailing edges of the rudder and elevators for directional and longitudinal trimming. A handle fitted with an indicator showing the position of the tab on the starboard aileron is mounted near the pilot's seat; while the tab on the port aileron can only be adjusted on the ground. The trimming tabs on the elevators are controlled from a hand wheel at the top of a column mounted on the starboard side in line with the control column and an indicator is fitted showing the position of the tabs. The trimming tab on the rudder is controlled from a handle, fitted position they show the word "Down" on a green background. When the units are not locked either up or down, or when the indicators are switched off, black and white dazzle lines are shown on the indicators. If the engine throttle levers are closed beyond about one-third open position, an electrical warning buzzer sounds until the undercarriage units are locked down. These indicators cannot be switched off unless and until the magneto switches are also "off."

The control for the flaps also moves in the same direction, namely, down to lower the flaps and up to raise them. The position indicator at the left of the flap control lever shows the position of the flaps, which can be lowered to any intermediate position between fully up and fully down, by returning the control lever to the gate in the middle of the quadrant, thus shutting off the control valve.

The direction and turn indicators and the artificial horizon are operated by one of two vacuum pumps, which are fitted to each engine. In the event of the failure of one pump, the other can be selected by means of a change-over control on the port side of the instrument panel. The vacuum available is shown on a gauge beside this control. The differentially operating brakes for the landing wheels are operated pneumatically.

Power for the electrical installation is derived from a 500-watt generator driven by the starboard engine, which provides current at 24 volts for the usual services, including landing lamps, engine starting, radio, gun firing, undercarriage position indicators and warning buzzer, camera, &c. The wireless installation is mounted in the fuselage between the centre plane spars on the port side, and comprises a transmitter and receiver, operated by the pilot by means of remote controls. Intercommunication telephones between the pilot and the observer are provided. Twin landing lamps are fitted in the leading edge of the port wing. The dipping of both lamps is controlled by a lever on the inboard side of the two-speed supercharger controls. Navigation identification and formation keeping lamps are fitted, controlled by a signalling switch-box on the starboard side of the cockpit, which provides for independent or simultaneous use of the upward and downward lamps, either through a telegraphic key for Morse, or, alternatively, a steady illumination. Intercommunication signalling between the pilot and the observer is provided by a buzzer and a white light on the observer's instrument panel in the rear fuselage, operated by a push button on the instrument panel. The observer can also operate a lamp on the instrument panel to attract the attention of the pilot. An emergency signalling system is also fitted, which is an entirely independent circuit, used only when abandoning aircraft. A push button operated by the pilot warns the observer to prepare to abandon aircraft, and when the warning light on the instrument panel informs the pilot that the observer is ready, a separate switch is depressed, signalling to the observer to abandon aircraft.

Two throttle control levers and a single mixture control lever are mounted on the engine control panel at the left-hand side of the pilot's seat. They are interlocked to prevent the engines from being run on an unsuitable mixture, and the stiffness of the controls can be adjusted. The fuel supply from the four main tanks is maintained by engine-driven pumps. For normal range flights the four fuel tanks are filled and the outer tanks are used first, the inner tanks being turned off by the fuel cock controls mounted on the port side of the pilot's cockpit. When the outer tanks are empty, the inner tanks are turned on. This automatically turns the outer tanks off. The constant speed airscrew controls are mounted alongside the throttle and mixture control levers. The two-speed supercharger controls are mounted in another quadrant aft of the throttle and mixture controls on the engine control panel. The air intake shutter levers are situated next to them.

The adjustable cowling gills are operated by electric motors controlled by switches on the engine control panel. Red warning lights indicate when the motors are in operation. The carburetter cut-out controls are situated in a control box with a spring-loaded cover fitted to the top of the front spar on the port side. Control levers have red knobs for the port engine and green for the starboard. The priming pumps and starting magneto switches for each engine are mounted on the nacelle structure above the undercarriage pivot and are accessible from the ground when the undercarriages are down.

In the event of the failure of one vacuum pump, the other can be selected by means of a change-over control on the port side of the instrument panel. The fuel in the four main tanks can be jettisoned in an emergency by a red painted lever on the instrument panel, which controls a pneumatically operated jettisoning valve on each tank.

The equipment of the "Beaufighter" is exceptionally complete, and includes navigation, identification and formation keeping lamps, landing flares, auto-recognition equipment, signal pistol, oxygen apparatus, cine-camera unit mounting, stowage for computors, map cases, &c., fire extinguishers, first-aid outfit, and axe. Emergency rations are stowed in the rear fuselage at the base of the observer's seat. Flying rations and water bottles are also carried. Other equipment provided includes the heating system, air-screw de-icing, oxygen apparatus, and Lorenz beam approach equipment. Provision is also made for carrying a 4-gallon water tank for desert use.

The Train and Motor-Car Ferry "City of Midland"

IN one of the paragraphs of "American Engineering News," which was published in our issue of July 18th, our New York correspondent made a short reference to the train and motor-car ferry steamer "City of Midland," which has recently been put into service on Lake Michigan. As the ship is an interesting example of her class and is propelled by uniflow steam engines of special design, some further particulars of her construction will be of interest to our readers.

The "City of Midland" was built by the Manitowoc Shipbuilding Company, of Manitowoc, Wisconsin, for the service of the Pere Marquette Railway Company, and is now in operation between Manitowoc and Ludlington on Lake Michigan. Her principal hull dimensions and machinery particulars are given in the table on page 94.

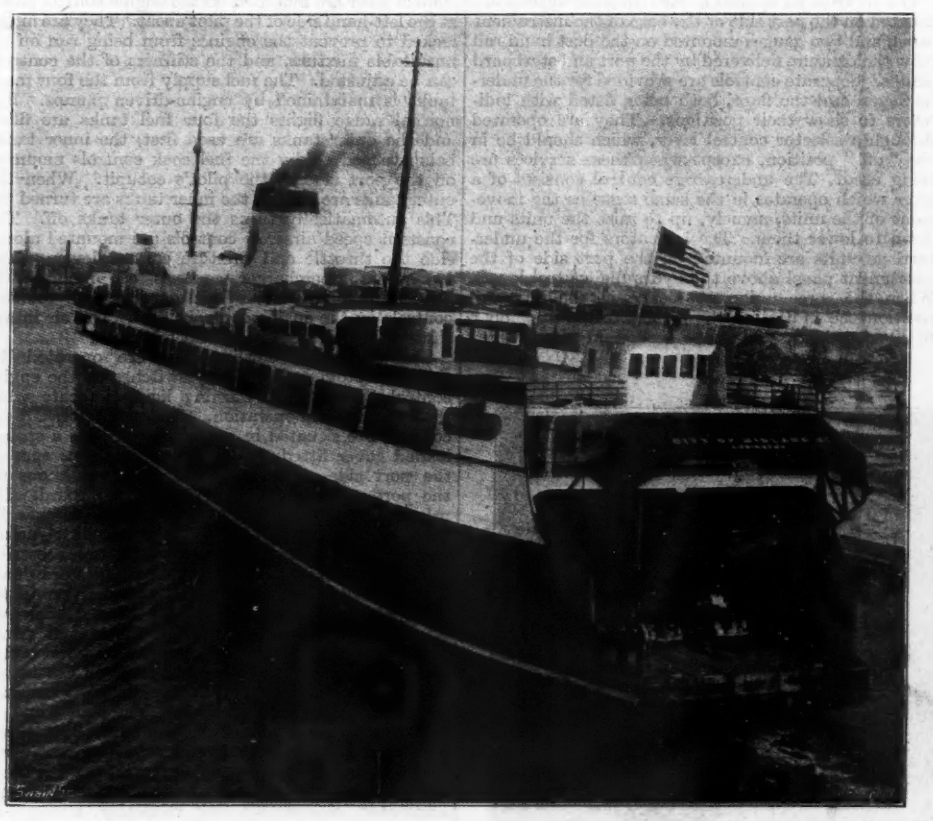
The accompanying engraving shows the general appearance of the new ferry steamer. The superstructure is streamlined, and there is a single funnel. The safety regulations of the Bureau of Marine Inspection and Navigation are more than covered, and the latest equipment for navigation has been fitted. The double bottom of the ship is strongly reinforced, and between the forward and after bulkhead there are nine bulkheads, subdividing the ship into ten watertight compartments. The bow of the ship is designed for ice-breaking, and the four railway tracks on the main deck will be seen in our illustration. Provision is made, it may be noted, to carry the motor-cars on the upper deck. Space is provided for about 34 loaded goods wagons, 50 motor-cars, and 376 passengers. The passenger accommodation comprises 74 state rooms and 12 larger rooms, a dining saloon for 60 persons, and two smoking rooms.

As the ship will be called upon to operate through-

out the year and in heavy ice conditions during the winter, it was decided to install steam machinery. A close investigation of the problem for over three years led to the adoption of the reciprocating steam engine working on the uniflow principle, this form of prime mover having low maintenance costs, strong and simple design, high economy, and ease in manœuvring with a large capacity for overloads.

The two main engines were built by the Skinner Engine Company, of Erie, Pa., and are claimed to be the largest marine engines of their particular type built to date. Each engine has five cylinders, with a bore of 25in. and a stroke of 30in., and when supplied with steam at 325 lb. pressure, 640 deg. Fah. total temperature, and exhausting to a vacuum of 26in., it is designed to develop 3000 S.H.P. at 120 r.p.m. An overload rating of 3500 S.H.P. at 125 r.p.m. has been fixed, but higher overloads are available. A simple uniflow principle is employed with poppet inlet valves and cut-off control. By this means the engine can be run at all speeds with a full open throttle, the speed being reduced by shortening the cut-off and increased by lengthening it, thereby maintaining full throttle pressure in all cylinders, under all conditions of load. An unusually flat steam-rate curve is obtained, from below half speed to above full speed. The engines are of the totally enclosed type, working with forced lubrication supplied to a circuit common to both engines, at a pressure of approximately 50 lb. per square inch. The control levers are arranged on the inner sides of the main engine frames, and the shortest lever is connected to the balanced throttle valve, which is mounted on the outboard side of the engine. The two longer levers are for the cut-off control, one for ahead and the other for astern, the levers swinging in the direction the ship will move. The cylinders, cylinder heads, and pistons are made from special alloy semi-steels, with hard cylinder walls of about 220 Brinell hardness, and a tensile strength of 65,000 lb. per square inch. Each main engine exhausts into an Ingersoll-Rand two-pass surface condenser of 2400 square feet tube surface, with ejector air pumps. The condenser is designed to deal with 46,000 lb. of steam per hour, and to maintain a vacuum of 26in. when supplied with 3200 gallons of cooling water per minute at a temperature of 70 deg. Fah. The boilers provide steam for propulsion, heating, and other purposes, and consist of four Foster-Wheeler "D" type marine steam generators, fired by Hoffman Combustion Engineering spreader type stokers, with special grates. A mechanical coal-handling system is employed, which conveys the coal from the bottom of a self-trimming storage bunker. A pneumatic ash-handling equipment is also installed. Power for lighting, heating, and auxiliary machinery is furnished by two Allis-Chalmers 240-volt, 500-kW, three-phase turbo-alternators.

We are indebted for these particulars to our American contemporary, the *Marine Engineering and Shipping Review*.



TRAIN AND MOTOR-CAR FERRY "CITY OF MIDLAND"

Particulars of "City of Midland"

Principal Hull Dimensions

Length overall	406ft.
Length between perpendiculars	388ft.
Breadth moulded	57ft.
Depth moulded to main deck	23ft. 6in.
Depth moulded to cabin deck	43ft. 2in.
Height of deck for wagons	19ft. 8in.
Displacement	8200 tons
Gross tonnage	6000
Service speed of ship	18 m.p.h.

Propelling Machinery Particulars

Type of machinery	Twin-screw uniflow steam engines
Number of cylinders each engine	Five
Diameter of cylinders	25in.
Piston stroke	30in.
Designed normal output each engine	3000 S.H.P.
Normal running speed	120 r.p.m.
Overload rating	3500 S.H.P.
Overload running speed	125 r.p.m.
Type of boilers	Foster-Wheeler "D" type
Number of boilers	Four
Normal capacity each unit	26,125 lb. per hour
Maximum capacity each unit	39,190 lb. per hour
Steam pressure at superheater	335 lb. per square inch
Final steam temperature	650 deg. Fah.
Temperature of feed water to economiser	225 deg. Fah.

The Heat Treatment of Aluminium and Its Alloys*

Solution Heat-treatment Practice

There are two important requirements for successful solution heat treatment. The first is the strict observance of correct temperatures, and the second the allowance of sufficient time at the appropriate temperature for complete solution of the hardening elements to take place.

In most of the well-known alloys there are low melting point constituents which fuse at temperatures not much in excess of those permitted, and the structure of overheated material cannot be modified by any subsequent treatment.

Time is a variable factor and will depend upon the type of furnace used, the size and weight of the articles being treated, and the physical condition of the metal. Size for size, castings require the longest soaking time as most of the hardening constituents situated within the crystal structure are in coarse form, and consequently take longer to dissolve. The working to which wrought products, such as sheet, forgings, and extruded sections, are subjected during manufacture tends to break down and disperse these constituents and make them more easily soluble, and there is considerable solution of these constituents during hot working also. Cracking under the press may be caused by insufficient soaking time at solution temperature, or lack of uniformity of temperature of the load as a result of inefficient spacing.

The coarser structure of castings makes very much longer soaking periods necessary, twelve hours being a common time. As this time will vary with the shape and size of the castings, the advice of the manufacturer should always be obtained. At solution heat-treatment temperatures, aluminium alloys are relatively soft, and large castings may require support and careful handling to avoid distortion. When manipulating intricate components and also in deep pressing work it is often found necessary to solution treat the material several times in order to obtain full deformation. Providing this is performed under closely controlled conditions, a reasonable number of treatments has no deleterious effect on the metal.

Choice of heat-treatment equipment may be influenced by the form of product being treated, but the types most generally in use are gas, oil, or electrically heated baths containing either fused sodium nitrate or a mixture of sodium and potassium nitrates, and air furnaces in which the air, heated as a rule by electric resistance elements, is forced by means of fans to circulate through the load at high speed. Each type has its advantages and disadvantages, but the fused salt bath is probably the most widely used. Its popularity is largely due to its high heat capacity, which ensures that the material being treated rises very rapidly to temperature, and with reasonable care uniformity of temperature is easy to obtain. High-speed air furnaces have been increasingly used in recent years, and satisfactory results are obtained, providing attention is given to efficient spacing and furnace atmosphere. If gas or oil is the heating medium used, it is essential that the products of combustion should not come into contact with the metal. Molten nitrate in contact with carbonaceous substances constitutes a serious fire hazard. Timber should not be used near a salt bath, or rags and oil be allowed to accumulate. The temperature of a heat-treatment furnace is liable to vary from time to time during operation, and whether a salt bath or forced air type is used, an occasional survey with a wandering thermo-couple is advisable in order to locate and correct hot or cold zones. In salt baths dross settlement on the bottom of the bath can easily give rise to hot spots and a periodic clean out of sludge from the bottom of the bath is desirable. Hot or cold zones can be caused in air furnaces by damage to baffles and blockage of air passages by scrap or dust. Efficient spacing of the load is very important in order to obtain uniformity of temperature, and in a salt bath circulation of the salt by gently agitating the load is recommended. Where possible in salt baths, sheet and coils should be stacked vertically to encourage flow of the convection currents in the nitrate, and a depth of at least 6in. of salt be maintained above and below the load. Quench water is usually kept at a temperature not greater than 25 deg. Cent., unless specified otherwise, and a separate tank with circulating water should be used for washing. If hot, wash water should not exceed 65 deg. Cent. The tendency of nitrate to absorb water makes it necessary to remove all traces of the salt from the metal to avoid subsequent corrosion troubles. Soft water should always be used when available.

The time lapse which occurs when transferring the material from the furnace or salt bath to the quench tank is a factor which may have considerable effect upon the properties of the alloy. Speed should be the keynote of this operation, and the interval should not be allowed to exceed 10 to 15 seconds for large loads, and less for small loads and single sheets.

Precipitation Heat Treatment or Artificial Ageing Practice

The precipitation heat treatment required by the artificially aged alloys is carried out on completion of the solution treatment by heating at a moderate temperature, which varies somewhat with the composition of the alloy. Air furnaces are almost exclusively used, circulation of the air by fan being essential. The process has the effect of increasing the ultimate tensile strength, proof strength and hardness, and decreasing the ductility and usually the impact strength of an alloy. With naturally ageing alloys, specification properties may be obtained after five days at room temperature, but in the case of the double heat-treated alloys, two factors—elevated temperature and time at that temperature—are mutually dependent in the process. It has been shown that at temperatures exceeding 140 deg. Cent. there is a more or less logarithmic decrease in the time necessary with rise of temperature. For example, an alloy which is fully aged in sixteen hours at 175 deg. Cent. will require five days at 140 deg. Cent. to reach the same state. At 200 deg. Cent. many alloys will be completely aged in two hours, but the treatment of large loads at this temperature is attended by some risk, as the time lag in bringing the whole batch up to correct temperature makes exact control very difficult.

The practical considerations applying to precipitation treatment are similar to those for solution treatment. Temperature ranges should be rigidly adhered to, and loads should be carefully spaced, in order to maintain uniform temperature conditions. It is advisable to pack thermo-couples in with the material in order to check the time at which uniformity of temperature is reached. When dealing with heavy masses of material, cooling, preferably by means of cold air blast, should be carried out as soon as the load is withdrawn from the furnace, as slow cooling is equivalent to an extension of the ageing period, and may result in inferior properties. This is not neces-

* Abstract from *Research and Development Bulletin* of the Northern Aluminium Company, Ltd. The original includes tables of recommended temperatures and times for "Noral" alloys.

sary where well-spaced loads or built-up structures are concerned, since these have a larger surface area for heat dissipation.

ANNEALING

There has in the past been some confusion regarding the correct procedure for annealing the heat-treatable alloys. As their treatment may be considered as falling into one or other of two fairly distinct processes, depending upon their condition, it is hoped that the following method of grouping the different types of alloys, with the method of annealing most desirable for each, will help to clarify the problem.

Group I: Strain Hardening (Non-heat-treatable) Wrought Alloys.—This group of alloys, including such specifications as B.S.S. 2 L 4 and D.T.D. 213, is not capable of being sensibly hardened by means of heat treatment. The only effects that have to be removed therefore are those of strain hardening, and the treatment for this is simply to heat as rapidly as possible to the temperature for the appropriate alloy. The soaking period will be least when fused salt baths are used, but in any case should never exceed one hour. Slow cooling is desirable, but the material may be quenched in water without serious effect on the softness. Quenching is, of course, necessary when a salt bath has been used in order to remove nitrate.

Group II: Heat-treatable Alloys which have been Strain Hardened Only.—These alloys, of which specifications B.S.S. 5 L 3, B.S.S. L 47, and D.T.D. 390 are examples, may have been purchased either in the annealed condition and subsequently hardened by bending or pressing, or in the hard rolled condition as a prelude to solution heat treatment and manipulation. The annealing process for such material therefore is required to remove strain hardening only, and the procedure outlined for Group I is sufficient, subject to the precautions imposed by the heat-treatable characteristics. At 340 deg. Cent., in addition to the annealing, slight solution of the hardening constituents may take place, so that there may be a slight degree of hardening due to heat treatment, particularly if material is rapidly cooled. The extent of the annealing is usually sufficient for most purposes, but the slower the rate of cooling, the softer will be the finished material.

Group III: Fully Heat-treated Alloys.—Alloys which have been solution heat treated and aged fall into this group, and can be softened to a reasonable extent by the process mentioned above, although the full effects of heat treatment are by no means removed. The ductility of metal so annealed is a little superior to that of the same alloy in the period immediately following solution heat treatment. Some age hardening does occur, particularly if the metal has been treated in a salt bath and quenched to remove the nitrate, and it is better to do any necessary forming within twelve hours of this anneal if possible.

For all heat-treatable alloys, whether they have been solution heat treated or only work hardened, a different method of annealing is required if their maximum ductility and softness are wanted. This process, which is sometimes known as "super-annealing," consists of soaking the material for a period of at least one hour at 425 deg. Cent., and then cooling it slowly, preferably in the furnace, at a rate of 10–15 deg. Cent. per hour, until the temperature has reached 270 deg. Cent., when the load may be removed and allowed to cool off in air. If prolonged occupation of the furnace is undesirable, the load may be transferred rapidly to a box or pit, well insulated with asbestos, where the retarded cooling can take place. Some modification of this treatment in respect of time at temperature and rate of cooling is permissible, according to equipment available and degree of softness required, but the longer the soaking period and the slower the cooling rate, the softer will be the material. "Super-annealing" is specially applicable in such instances as the upsetting of wire or rod and the deep drawing and stretching of sheet. Heat-treatable alloys which have been annealed will require solution heat treatment and ageing before they acquire their full specification properties.

SHIPBUILDING IN SWEDEN

A MARINE survey vessel of about 600 tons was launched recently at the Finnboda shipyard in Stockholm for the Swedish Chart Office. The vessel, which received the name of "Gustaf af Klint," after one of the founders of the office, will be most modernly equipped for the taking of sediment samples, and will have radio sounding equipment, gyro-compass, Sal log, &c. The vessel is equipped with an adjustable blade Swedish Ka-Me-Va propeller, driven by a 560 H.P. Polar oil engine. The ship is intended especially for charting and sea investigations in the Baltic. On the same day the shipyard delivered to the Swedish Navy a combined minesweeper and escort vessel of about 400 tons. It is one of the last in a series of twelve such vessels built at various Swedish yards last year. In the beginning of June a motor cargo ship of 10,000 tons deadweight was launched at the Oresund shipyard for the Swedish East Asiatic Company. The ship, which received the name of "Bali," will be propelled by two Gotaverken oil engines, designed to give a loaded speed of 16 knots.

Markets, Notes and News

The prices quoted herein relate to bulk quantities. Unless otherwise specified home trade quotations are delivered f.o.t. Export quantities are f.o.b. steamer

Changes in Export Control

Under a Board of Trade Order signed on July 31st and coming into force on August 14th, 1941, licences will be required to export to all destinations certain additional manufactures of iron and steel, all kinds (including certain specified parts therof), of mechanically propelled road vehicles, and further types of electrical measuring instruments. The Order (S.R. & O., 1941, No. 1072) also prohibits the export without licence of antimony oxides and hydroquinone, metol, and mixtures containing either or both of these materials, and extends the existing prohibition in respect of jute manufactures, asphalt, bitumen, and pitch (whether natural or not) and certain mixtures of waxes. Copies of the Order are now available at H.M. Stationery Office.

The Pig Iron Market

Conditions in the pig iron trade are steady and it is not anticipated that there will be much change in the immediate future. The demand for ordinary high-phosphoric foundry irons is only moderate, since the light castings industry is not well occupied, but there has been no decrease in the demand for other descriptions of pig iron. Foundries requiring high-phosphoric iron have no difficulty in obtaining all their requirements from the Midland furnaces, which are now supplying many districts in England and Scotland with this class of pig iron, for which licences are freely obtainable. In a number of cases consumers are doing their best to lay in stocks, for whilst at this time of the year transport difficulties are no worse than normal, the long rail haul to some districts might present greater hindrances during the winter, and the possession of stocks gives consumers a feeling of security, and at the same time the Control favours this policy where it is practicable. There is an active demand for low-phosphoric iron and hematite, supplies of which are stringent. Hematite, in particular, is in rather short supply, and the Control is keeping a very careful eye upon its distribution. The heavy engineering trades are big users of both hematite and low-phosphoric pig iron, and the demand is likely to be maintained for a long time, as this industry is almost entirely engaged on war work and has priority claims. The Control, however, has avoided any dislocation of operations at establishments engaged upon essential work. Wherever necessary, imported iron is distributed, and this has helped to maintain a satisfactory flow to consumers. In many works the use of substitutes for customary descriptions continues, and refined and high-phosphoric mixtures are used in furnaces to a greater extent probably than ever before.

Scotland and the North

Following the Glasgow Fair holidays there was a general resumption of work at the Scottish steel works, and operations were soon proceeding at as great a pressure as before the break. There is, nevertheless, a noticeable tendency for the demand to decline in volume, although practically all the orders coming forward are of an urgent character. The volume of Government contracts in hand, however, is sufficient to keep the works fully employed for many weeks to come, and there is little likelihood that they will be short of orders during the war. In the present state of business, however, deliveries are being made much more frequently than for many months. The restriction upon the supply of steel for anything but essential purposes is now having its effect upon the industry and all those firms engaged upon war work are reaping the benefit. The call for the heavier production of tanks is expected to result in an increased demand for plates and certain sections. The requirements of the armament and munition makers of special steels have not decreased, and there is a considerable tonnage passing to those branches of the industry. So far as semis are concerned, the position seems to have greatly improved. The whole of the British production is, of course, going into immediate consumption, and lately there have been more liberal deliveries of imported semis, with the result that the re-rolling works in many cases have been able to accumulate fair stocks, which should assist them during the winter months, when transport difficulties may be greater than at present. A substantial volume of orders for finished iron and steel were placed immediately following the holidays in the Lancashire district. All the engineering works are employed on war contracts, and have full order books, so that there is little likelihood of their requirements declining for some time. Orders for special steels, including nickel, nickel-chrome, and other alloy steels, have been a feature of the market. The activity at the engineering works has led to a strong demand for bars of all sizes. On the other hand, the sheet trade has become somewhat quieter, and most works report that the volume of new orders shows a noticeable decline.

The North-East Coast and Yorkshire

The impression is gaining ground in more than one district in this country, and particularly on the North-East Coast, that the production of steel is overtaking the demand. No doubt the greater attention which is being paid to the diversion of all steel supplies to essential war work has had much to do with the lessening requirements of the consuming trades, but at the same time there is a noticeable decline in some directions in the demand for finished steel. This movement was first evident in the falling-off in business in heavy joists and structural steel. This is still apparent, although there remains a brisk demand for the lighter joists and sections. Now that the rush to place the allocations for third-quarter delivery is over, most works report a slackening in new business, which under the present conditions can scarcely be due to seasonal causes. Stocks of semis have been accumulated by many consumers, and for some time now there has been an easing in the situation, due to the more liberal distribution of stocks of imported semis. There is still some tightness in the plate position, and it is believed that this will continue to exist for some time, since not only are the shipyards absorbing large quantities, but the tank makers, and locomotive and wagon builders are all extremely busy. The boilermakers, also, have sufficient work in hand to keep them occupied for a long time. The sheet mills are experiencing a decline in the volume of new business, which is ascribed to the fact that most of the orders for sheets for air raid shelters have been completed. Although many of the Yorkshire steel works closed down for the Bank Holiday, it was generally in order to effect the necessary repairs to plant. All the steel works have full order books, and the call for soft basic steel material is unabated. There is also a heavy demand for acid carbon steel. The increased demand for special steels has been maintained, and shows a tendency towards a further expansion.

Copper and Tin

The copper situation in Great Britain gives cause for congratulation. The demand is on a heavy scale, and practically all the consuming works are engaged upon war contracts. Deliveries, however, are regular and satisfactory supplies continue to reach this country; in fact, it is understood that in some cases copper has been stocked by works to be used as required, by arrangement with the Control. The distribution of copper is naturally carefully safeguarded, and supplies for unessential purposes are difficult to obtain. In the United States the position is becoming increasingly similar to that existing in Great Britain. The metal passing into ordinary commercial work is declining in volume, and there is, of course, no export trade. Permits are needed to acquire, manufacture, and export copper materials, and the Control is understood to be most efficiently enforced. At the same time there is a considerable discussion as to American requirements of copper in the future, and some talk that the production will not be sufficient to meet the country's needs. In that event large supplies can be obtained from South America, and, in fact, it is possible that the United States will take as much copper from South America as is necessary, to prevent any being bought for the Axis countries. . . . Following the somewhat panicky buying which developed upon the news of the Japanese occupation of Indo-China, and which raised tin prices, the market again receded to the former levels. There is some nervousness apparent that the Japanese action may result in an interruption to supplies, but this has been allayed to a certain extent by the action of the United States authorities in indicating to consumers who had laid in stocks that they should not make fresh purchases until all these had been used. So far as the tin situation is concerned generally, production appears to be in excess of consumption, and there seem to be ample supplies available.

Lead and Spelter

The position of the lead market in Great Britain continues satisfactory, and, in fact, there has been little change in the situation for some weeks. The steps taken before the outbreak of war to ensure supplies of Empire lead have proved successful, and the metal seems to be reaching this country with regularity. The position is sufficiently easy to enable a certain amount of lead to be distributed to firms engaged in making exportable products. In other directions the demand is heavy, principally on account of war work. The cable and battery trades are particularly heavy users, and large tonnages are passing into consumption in those industries. Some interest is taken in the quantities of lead which are to be shipped to the United States as a result of purchases by the American Metals Reserve Company, the American buying organisation. . . . The demand for spelter has reached high figures in Great Britain, as considerable supplies are required for war purposes. On the other hand, consumption is understood to have been affected as a result of the decline in the demand from the galvanisers. Lately the United States has sent certain quantities of zinc here, and this has helped the situation, which, nevertheless, remains tight in practically all countries excepting Germany, who by over-running so much of Europe has obtained a substantial productive capacity. It is doubtful, however, how much of this plant can be used, since much of it relied upon imported zinc ores, which, owing to the British blockade, are not now available. The British Non-Ferrous Metals Control is carefully supervising the distribution of metal, and apparently the supplies are adequate, since no reports have been received of inconvenience being caused to the war industries by belated deliveries. In the United States tight conditions have ruled for some weeks, but do not seem to be getting worse. According to statistics, available supplies of spelter to United States consumers this year should be about 900,000 tons.

Non-ferrous Metal Prices

The London Metal Exchange official statement for July again indicates a slight decline in the average quotations of tin of £4 8s. 9d. for cash and £3 1s. 4d. for three months, compared with the June average. The settlement average is £4 7s. 8d. below that for the previous month. The statement, which includes the official maximum prices for copper, lead, and spelter, is as follows:—

Standard tin	Cash (mean)	£258	8	9½
	Three months (mean) ...	£261	10	0
	Settlement	£258	9	4½

The following prices for copper, lead, and spelter are the maximum prices fixed by the Controller of Non-ferrous Metals:—

	£	s.	d.	
Standard copper	—			
Electrolytic copper ...	62	0	0	delivered buyers' premises
Electrolytic wire bars ...	62	0	0	,, ,,
Best selected copper ...	60	10	0	,, ,,
Lead, good soft pig (foreign) ...	25	0	0	,, ,, (duty paid)
Spelter, G.O.B. (foreign)	25	15	0	delivered buyers' premises (duty paid)

Notes and Memoranda

Rail and Road

Joint Closure.—The Canadian Pacific and Canadian National Railways recently sought permission to close three sections of line in Manitoba. The application was turned down, however, by the Canadian Board of Transport Commissioners.

Money for Railway Works.—The Uruquay Government has allotted nearly 2,000,000 pesos for the construction of an extension of the State Railway from the Sarandi del Yi al Norte line to Banquillo near the Rio Negro, a distance of 40 kiloms.

Across the Track.—The Maine Central Railway recently transported ninety large marine boilers by regular trains in groups of three, from Schenectady, N.Y., to South Portland, Me. A circuitous route was chosen so as to allow the boilers to be loaded across the trucks instead of along them as is usual.

A Grand Trunk Bridge.—A single-span reinforced concrete bowstring bridge, the first to be constructed in the province, replaces the suspension bridge which carried the Grand Trunk Road of India over the River Durgawati. The new bridge, which was completed in June, has been built to withstand heavy traffic.

Given Away by the Germans.—The Bulgarian State Railways have taken over the Jugoslav and Greek railways in the territories allotted to Bulgaria by the Germans. The transfers include the Jugoslav main line sections between Tsaribrod and Nish, on the Sofia-Belgrade trunk line and between Nish and Ghevgheli, on the Salonika line.

Moscow Railway Facilities.—There are no fewer than nine railway stations in Moscow operated by eleven lines. Over 4,000,000 tonnes of outwards and nearly 23,000,000 tonnes of inwards goods are handled yearly. Inwards traffic consists of coal, petroleum products, metals, timber, and grain, and outwards of machinery and manufactured metal goods and foodstuffs.

Taking No Chances.—Steps are being taken to dismantle some 110 miles of permanent way and other equipment from the Chinese section of the French Yunnan and Indo-China Railway by the Chinese Government, which controls the section. Some of this has already been used to equip a section—recently opened for traffic—from Kunming towards Suifu and Chungking.

Fuel for Eire.—The Minister for Industry and Commerce in Eire has made an order empowering either the Turf Development Board or the Electricity Supply Board to construct a light railway connecting Clonsast bog with the Great Southern Railways main system. The extension of the existing narrow-gauge line to a point on the G.S.R. main line north of Portarlington will serve points on the Great Southern system.

Victorian Government Locomotives.—The design of a new type of 4–8–4 locomotive built at the Newport shops of the Victorian Government Railways, and recently introduced in service between Melbourne and Albury, New South Wales, was in part influenced by the necessity of keeping the total wheel base within the limits of the existing 85ft. diameter turntables installed at locomotive terminals which at present, or in the future, are likely to handle the engines.

The Burma and China Railway.—British interests in the Far East are interested in an announcement that the British Government has agreed to provide funds to enable the Government of Burma to build a railway line from the railhead at Lashio to the frontier. This will link up the Burma railway system with that of China, and is rendered necessary by the fact that the Burma and Yunnan road has proved to be inadequate for the traffic between the two countries.

Bridge at Port Adelaide.—The Australian Institution of Engineers recently published a paper by Mr. J. P. McMahon on a new highway bridge over the Port Adelaide River. The Birkenhead Bridge, as it has been named, is 808ft. in length, has a 100ft. central navigation opening crossed by double-leaf bascule spans, and is flanked on the south by one 36ft. and three 100ft. deck plate girder spans, and on the north by two 36ft. and two similar 100ft. spans. The bridge rests on 458 timber piles carrying concrete piers.

Waterproof Plywood.—An American timber house, which has supplied the makers of lorries and wagons with plywood for ceilings and inside walls, is now providing plywood for the exterior siding and roofs of freight and refrigerator vans. For these jobs, where the panels are constantly exposed to the weather, waterproof plywood is utilised. Whey plywood first came into prominence as a material for American van construction five years ago, it was applied to ceilings to prevent condensation and thus eliminate damage claims. Since then a number of railways have standardised on plywood ceilings for steel-roofed vans. Later, it was used for the interior walls of the vans to protect the shipments. It was found that the plywood panels are shockproof and splitproof, qualities contributing to lower maintenance cost.

Air and Water

Indian Sea Lighters.—The possibility of constructing sea-going lighters in India is under investigation and inquiries are being made to find out how much time would be required to procure the necessary material for their construction.

A Notable Special Number.—On the occasion of the Convention of the American Waterworks Association in Toronto, our Canadian contemporary, *Engineering and Contract Record*, compiled and published a list of the water supply systems of Canada. Some 500 cities and towns were given, each with the source of supply, method of purification, pumping plant, and mileage, and dimensions of pipe line. The information was arranged by provinces, and was supplemented by the names of engineers, superintendents, and commissioners in charge of the operation of these municipal water supplies.

Russian Liquid Air Process.—The Commissariat of Heavy Machine Building of the Soviet Union is building plant in one of its factories for the manufacture of liquid air and oxygen by the method due to Professor P. L. Kapitza, Director of the Institute of Physical Problems of the Academy of Sciences of the U.S.S.R.

Germany Supplies Japan.—Manchuria's electric power output will be increased 60 per cent. during the current year, according to reports received by the U.S. Department of Commerce. Four hydro-electric generators have been completed in Germany for the Suiho dam on the Yalu River. These units will each produce 100,000 kW.

Bridges in Mysore.—When, earlier in the year, the Maharaja of Mysore laid the foundation stone of a bridge across the Bhadra River near Kalasa, he indicated the possible building of others. The first is that over the same river near Holehonnur village. The second would be across the Kumudvati River near Salur village on the Anantapur and Shikarpur road; and a third across the Gondi Hole near Anavatti.

Government Requisition Boats.—The Southern Pacific Railway Company has been directed by the United States Maritime Commission to turn over to the Government its entire fleet of ten vessels for national defence purposes. This fleet of cargo ships has for many years operated as the Morgan Line, and has been engaged in coastwise trade from New York and Baltimore, Md., to Galveston, Tex., and Houston.

Telephone Statistics.—Figures have recently been published which reveal that in 1940 the total number of telephones installed in the world was 42,642,252, or 1·97 per 100 population; 60 per cent. of the world's telephones are operated under private ownership, while the remaining 40 per cent. is under Government ownership. America leads with 22,558,727 telephones, 52·9 per cent. of the globe's total; second was Europe, with 15,765,994 phones, 36·97 per cent. of the world amount; Asia comes third in the list with 1,921,499 phones, or 4·51 per cent. of all. This is due to the fact that Japan possesses 1,367,958 telephones, or 3·21 per cent. of the world total.

Miscellanea

Blue Print Paper.—The expansion of engineering in India has led to the founding of a subsidiary industry for the production of paper for blue prints in Calcutta.

China Clay in Demand.—Several china clay pits in Cornwall have been reopened. Lee Moor pit, the largest in the world, and the Cholwichtown pit, are already in production, and a third at Whitehall Yeo is expected to be working again soon.

Openings for Graduates.—The General Electric Company of America has picked more than 250 college seniors to enter its business training course, the largest number ever taken on for training since the department was formed twenty-three years ago.

Plant for Nickel Production.—The Canadian Minister of Munitions and Supply has announced that arrangements have been made under which the International Nickel Company will spend 25 million dollars on plant extension to meet the needs of Canada and the United States.

California Needs Power.—The recent visit of Lord Halifax to California adds significance to the announcement that two 10,000-kW steam turbo-generators are being installed in the modern steam plant for the Burbank (Calif.) Public Service Department to meet unprecedented load growth brought on by defence industries.

Chrome Ore for Canada.—Time was when the chromite deposits in the Thunder Bay area of Ontario were worked by the Chromium Mining and Smelting Corporation, but later were abandoned as uneconomical. Now, mines of the Thetford and Sherbrooke districts near Quebec are being re-examined and new discoveries are reported.

The Millionth Telephone.—The Museum of Science and Industry in Chicago has accepted a contract from the Bell Telephone Company and Western Electric, Inc., that calls for enlarging and rearranging the telephone exhibit in the Museum. This new exhibit, which demonstrates the scientific harnessing of sound waves for telephonic communication, will include the millionth telephone installed in Chicago. There will also be a display of instruments from early communication sets to the present time.

The Melchett Medallist for 1941.—At a recent meeting of the Council of the Institute of Fuel, it was unanimously decided to award the Melchett Medal for 1941 to Dr. Clarence A. Seyler, D.Sc., F.I.C., F. Inst. F., of Swansea, as some recognition of the research work on coal and its constitution that he has carried out and published for the benefit of the world at large over a period of many years. It is hoped to present Dr. Seyler with the Melchett Medal in October next, when he will give the Melchett Lecture.

Japan's Needs.—All sorts of imported stores are becoming scarce in Japan. The shortage of carbon black is acute. A scheme for the control of glue and gelatine raw materials has been launched, and its activities are affecting finished products. Japan is also short of industrial salt, and research is being made to extract alkali products from sea water. The Meiji Mining Company is planning to build a plant at Kushiro to produce caustic soda, hydrogen, chlorine and magnesium in one process and hydrochloric acid as a secondary activity. The process has been developed by Hiroshi Suzuki, former President of the Research Institute of the Monopoly Bureau of the Ministry of Finance. Salt production and distribution is a Japanese Government monopoly. The discovery in Iwate Prefecture of what may prove to be extensive deposits of workable lithium ore is announced.

Welded Structural Work.—In the Benjamin Franklin High School, now under construction in New York City, the intention is to use welding for the whole framework, in which 2600 tons of steel will be required. Trusses, with spans up to 80ft. long, and weighing 19 tons, have been erected and welded in position.

Vanadium Supplies.—The American authorities are taking energetic steps to stop the leakage of steel-making metals from South America into Axis hands. The largest producer of vanadium ore is Peru, with the United States, South-West Africa, and Northern Rhodesia supplying practically the whole of the balance in the world's supplies.

Too Many Potatoes.—In order to utilise the surplus potatoes grown in British Columbia a plant for the production of starch and glucose from surplus potatoes is to be erected in New Westminster, British Columbia. For this development, Mr. J. Lifszyc, a former director of European starch factories, will be responsible. He is a member of a family that had been in the starch manufacturing business for several generations.

Progress in the D.E.I.—Despite war conditions, progress in industry is reported from the Dutch East Indies. A sulphuric plant to cost 8,000,000 qrs. is shortly to be built at Tjepoe, Java, with production expected to be started by the end of next year. Another Government-sponsored project for the production of potash fertilisers was started in 1940, and besides meeting the needs of the Netherlands Indies is building up surplus for export.

Wartime Iron.—The Institution of Mechanical Engineers, through its Research Committee on High Duty Cast Irons for General Engineering Purposes, has recently issued two reports. The first covers "Austenitic and Martensitic Irons," and the second "Phosphoric High Duty Irons," both reports having been prepared by Mr. J. G. Pearce, M.Sc., M.I. Chem. E., the Director and Secretary of the British Cast Iron Research Association.

National Building Council.—The Minister of Works, in pursuance of the policy of co-ordinating the wartime building effort of the country, has decided to establish a National Building Council representative of the principal interests of the industry. The names of the members of the Council will be made public in the near future. In the meantime, it is announced that the official Chairman will be Mr. Hugh Beaver, M. Inst. C.E., M.I. Chem. E., Director-General of the Ministry of Works and Buildings; Sir Ernest Simon will be Deputy Chairman.

The Demand for Glycerine.—The war has led to an increase in the demand for glycerine, and chemists and engineers are seeking for improved methods of production. Among these is one worked out in South Africa by the National Chemical Products, Ltd. This development, due to Dr. A. J. Viljoen, technical manager of the company, uses molasses which are fermented by means of a special yeast under alkaline conditions. The resulting wash is concentrated in special evaporators and the glycerine solvent extracted from the concentrate. After evaporation of the solvent, the crude glycerine is purified and distilled.

American Scrap.—America is waking up to the fact that there is a lot of scrap lying around. Mr. R. L. Williams, chief executive officer of the Chicago and North-Western Railway Company, has requested his operating department to make an immediate survey throughout the 10,000 miles of territory served by the railway to determine what amount of dormant scrap metal is available for defence purposes in small communities and agricultural sections not served through normal trade channels. Mr. Williams has already had reports of dumps full of old automobiles, farm implements, and other discarded metal objects, which were simply rusting away. "Apparently," he comments, "no effort has been made for years to clear any of this scrap, and it stands to reason that in these small towns and on farms there is little or no commercial effort to dispose of this material."

Improving Concrete.—Recent research in America indicates that improvements in concrete can be obtained by additions to cement of such organic materials as mineral oils, animal or vegetable fats, or natural resins. The plan results in concrete of greater impermeability, improved workability, and reduced bleeding. Some reduction in strength occurs, but resistance to freezing and thawing is substantially increased. The quantity of material which may be added to Portland cement without more than moderate reductions in compressive strength or increases in air content of concrete is dependent on the character of the added material, the type of concrete mix, and to some extent the composition or other properties of the cement to be treated. The optimum quantities are about as follows:—Mineral oils, 0·04 to 0·06 per cent.; animal fats or oils, 0·01 to 0·03 per cent.; Vinsol resin, 0·02 to 0·03 per cent.

Personal and Business

The Minister of Aircraft Production has appointed Mr. G. W. Lacey to the post of Light Metal Controller.

The Minister of Supply has appointed Mr. C. H. Lee to be Director of Administration in the Ministry. He will advise on questions of organisation.

Mr. S. J. Hungerford has resigned his office as president of the Canadian National Railways, but is to retain his position as chairman of the board. The new president is Mr. R. C. Vaughan.

Mr. R. Townend has been appointed chief engineer of the plant department of Metropolitan-Vickers Electrical Company, Ltd., in succession to Mr. G. A. Juhlin, who was recently appointed chief electrical engineer.

Mr. Horace Shankland, a local director of the Dunlop Rubber Company, Ltd., and a director of the India Tyre and Rubber Company, Ltd., has been elected President of the Society of Motor Manufacturers and Traders, in succession to Mr. William E. Rootes, who has accepted the position of Deputy Chairman of the Committee of Supply at the Ministry of Supply.